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John Snow

SNOW ON CHOLERA

BEING

A REPRINT OF TWO PAPERS

BY

JOHN SNOW, M.D.

TOGETHER WITH

A BIOGRAPHICAL MEMOIR

BY

B. W. RICHARDSON, M.D.

AND

AN INTRODUCTION

BY

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PREFACE.

THE republication of these significant papers was suggested to the Commonwealth Fund by Delta Omega, honorary professional society in public health, whose interest in a series of public health classics was first expressed in 1931 in a reprint of William Budd's Typhoid Fever, Its Nature, Mode of Spreading, and Prevention. The publication committee of that society assembled the greater part of the material for the present volume. Acknowledgment is also made to the committee's chairman, Homer N. Calver, for helpful suggestions ; to the staff of the London School of Hygiene and Tropical Medicine for interesting and valuable references ; to the United States Army Medical Library for making original material available ; and to Messrs. J. and A. Churchill and to Longmans, Green and Company, who courteously agreed to this republication of material originally published by them or their predecessors. Especial thanks are due to Dr. Wade Hampton Frost for his assistance in the selection and arrangement of the material and more particularly for his interpretative introduction which orients the present-day reader with respect to the significance of Dr. Snow's contribution.

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~~Public Health~~

A NOTE

ON THE TYPOGRAPHY OF THIS BOOK

The Scotch-face type in which this book is set is a close approximation of the type used in the second edition of "On the Mode of Communication of Cholera." This article has been set to resemble the original, the pages and even the lines corresponding exactly to it; and the inconsistencies in spelling and footnotes and the division of words, which in some instances do not correspond with modern usage, have also been carefully followed. The other two articles, "On Continuous Molecular Changes" by Dr. Snow and "John Snow, M.D." by Dr. Richardson, appeared originally in different formats; their reproduction in this book matches the format of the first article and also somewhat retains the spirit of their original style. The binding resembles that used on the second edition of "On the Mode of Communication of Cholera," the lettering and the blind stamping of the original shelf-back are reproduced and the cloth is of the same color.

CONTENTS.

INTRODUCTION	ix
JOHN SNOW, M.D., A REPRESENTATIVE OF MEDICAL SCIENCE AND ART OF THE VICTORIAN ERA, BY B. W. RICHARDSON	xxiii
ON THE MODE OF COMMUNICATION OF CHOLERA	
PREFACE TO THE SECOND EDITION	[iii]
CONTENTS	[v]
ON THE MODE OF COMMUNICATION OF CHOLERA	1
ON CONTINUOUS MOLECULAR CHANGES	
PREFACE	145
ON CONTINUOUS MOLECULAR CHANGES	147
APPENDIX	
I. CHOLERA AND THE WATER SUPPLY: LATER PAPERS	179
II. THE PRINCIPAL WRITINGS OF JOHN SNOW, M.D.	187

he was obliged to follow. But his argument has the permanence of a masterpiece in the ordering and analysis of a kind of evidence which enters at some stage and in some degree into every problem in epidemiology.

Looking back to the time when Snow wrote, we are apt to be more impressed with the deficiency of his knowledge, lacking all that the technique of modern bacteriology has since supplied, than with the extent and significance of the positive facts at his command. With some exceptions, the communicable diseases of man and the domestic animals which are of common occurrence in Europe had been differentiated clinically ; their gross and microscopic pathology was fairly well established ; their characteristic distributions in nature were known, and it had been demonstrated for not a few of them that they could be artificially transmitted by inoculation of "morbid matter" in minute quantity. But for certain diseases, including the enteric infections, this demonstration was lacking, and the indirect evidence of communicability was by no means so plain as to be incontestable.

Ideas as to the nature of the *materies morbi* were converging toward present-day conceptions, but were not at all clearly focused. The analogy between infection and fermentation, which Fracastorius had perceived three hundred years earlier, was generally recognized ; and moreover it was known that the proc-

esses of fermentation and putrefaction were constantly associated with the presence of living organisms of microscopic size, though whether or not these were spontaneously generated was still a matter of controversy. The active agent in conveyance of infection was generally pictured as being related in some way to the lower orders of known micro-organisms, but not usually as being itself a living organism, still less commonly as being an obligate parasite, bound by the law of biogenesis as now accepted. A general theory of infection closely approximating modern views had, indeed, been clearly formulated by Henle, in 1840, but it had not been widely accepted. The more common view related infectious diseases to micro-organisms much more loosely ; and in England, the ideas embodied in the so-called “pythogenic” theory were much in favor.

In this state of uncertainty as to the nature of the more common diseases, cholera presented a riddle peculiarly difficult to solve by the indirect method of inference from its mode of occurrence. The difficulty was not lack of detailed information. The epidemics which swept across Europe in the middle third of the century were matters of tremendous concern and were diligently studied by official commissions and individuals. In England, where epidemics prevailed in 1831–32, 1848–49, and 1853–54, the studies were of notable excellence. The genius and industry of William

Farr produced comprehensive reports of the epidemics of 1848-49 and 1853-54, and supplied current information while they were in progress ; admirable factual reports were made by the General Board of Health and the Royal College of Physicians ; and the literature of the day contained innumerable detailed accounts of the local dissemination of the disease. But the facts themselves were most confusing. Instances of local spread with every appearance of direct communication from person to person were offset by equally striking instances of failure to spread to those in close contact with the sick, and of the disease developing without traceable relation to prior cases. Moreover, the variations in the local prevalence of cholera appeared to be capricious in the extreme. If it seemed to be the rule that it prevailed most severely in low-lying places, and in a notably filthy environment, the exceptions to these and similar laws were too numerous to be disregarded.

The theories evolved to explain these complex facts were numerous and diverse, but so far as any one idea was dominant it was probably that expressed by Sutherland as follows:

It appears as if some organic matter, which constitutes the essence of the epidemic, when brought in contact with other organic matter proceeding from living bodies, or from decomposition, has the power of so changing the condition of the latter as to impress

it with poisonous qualities of a peculiar kind similar to its own.*

To this was added the conception of “localizing influences” promoting the propagation of the poison, and “predisposing causes,” increasing susceptibility to its effects. There were many differences of opinion as to whether the “cholera poison” might be spontaneously generated in different countries, or must be introduced from pre-existing foci ; whether it was spread solely by diffusion through the atmosphere or attached itself to solid bodies ; whether or not it was communicated by an effluvium (contagion) given off by the sick.

It is easier, at this distance, to see the defects in the current theories than to do them justice. Some were so vague and general as to be manifestly worthless, fitting one set of facts as well as another ; others simply ignored some of the plain facts, as for instance when the General Board of Health resolutely closed its eyes to all evidence of communication from person to person or by commerce. But there were at least a few theories, such as Farr’s, emphasizing the importance of elevation and drainage, which were well reasoned in accordance with an impressive array of facts. It is perhaps significant that they were directed so largely toward explanation of those phenomena of cholera which are still least explicable : its sudden extensions

* Sutherland, John, *in* Report of the General Board of Health on the epidemic cholera of 1848 and 1849, London, W. Clowes & Sons, 1854, Appendix (A), p. 8.

around the world, the vagaries of its geographic distribution, and its relation to climate, season, and weather.

How Snow perceived the thread of consistency which connected a seemingly chaotic mass of facts and followed it through to the conclusion that bacteriology has since confirmed, he himself tells plainly and simply, with the fresh enthusiasm of discovery, the restraint of a scientist. His account should be read once as a story of exploration, many times as a lesson in epidemiology.

In order to present the whole of Snow's argument, this volume reproduces in their entirety two of his works, his treatise *On the Mode of Communication of Cholera*, as published in 1855, and his address *On Continuous Molecular Changes, More Particularly in Their Relation to Epidemic Diseases*, delivered in 1853. The first of these is, by itself, a full and sufficient exposition of Snow's theory, evidence, and methods as applied to the specific problem of cholera. The second is important as connecting his views on cholera with his broad conception of epidemic diseases in general and relating these, in turn, to other natural phenomena. Together, these two dissertations show, one in broad outline, the other in detail, the pattern of his thought in epidemiology ; his other papers in this field are not without interest, but they all fit into this general pattern, and their reproduction is not essential to the main pur-

pose which this volume is intended to serve. Two of them, however, need to be mentioned, a prelude and a postscript, respectively, to his major work on cholera.

The treatise *On the Mode of Communication of Cholera* which is reprinted here is a second edition, "much enlarged," of a pamphlet published in the summer of 1849. This was followed immediately by a somewhat more extended paper published under the title "On the Pathology and Mode of Communication of Cholera" in the *Medical Times and Gazette* of November 2 and November 30, 1849. The essential difference between these two earlier papers and the expanded edition of 1855 is that the latter contains much new factual evidence, chiefly the analyses of mortality as related to the several water supplies of London in 1832 and 1849 and, of course, all the observations made in 1854. It has seemed unnecessary to reproduce the first paper in this volume, since it is included, for the most part in identical or slightly revised language, in the second edition; but it is important to remember that when Snow undertook his personal investigations in the epidemic of 1854 he already had in mind a definite and well matured theory which he was eager to put to the rigid test which the intermingling of two water supplies made possible.

The postscript to Snow's work of 1855 is his paper on *Cholera and the Water Supply in the South Districts of London*, published in October, 1856, when detailed

statistics of the population using the two principal water supplies in each subdivision of this area became available from the report of an official inquiry conducted by the General Board of Health. Of this a brief account is given in an appendix to this volume. It is not altogether essential to Snow's original argument, which was already well established, but confirms it in detail and shows his keenness in statistical analysis.

How far Snow's ideas were original is difficult to determine. He read widely and drew upon the ideas as well as the facts of his day, and it is certain that the general conception of epidemic disease which he expressed was not altogether unfamiliar at the time. Henle, approaching the subject from a different angle, had already expressed broadly similar views as to the nature of infectious diseases and, though no direct allusion to his work has been found in Snow's writings, he must have known of it, at second hand if not in the original. Budd certainly shared Snow's views, but notwithstanding that he himself had arrived at similar conclusions concerning cholera as early as 1849, he generously accords Snow full credit for independent and more complete development of the theory. The belief that cholera was communicable from person to person through a specific poison was not unusual. Some part of Snow's conception that cholera was due to a specific micro-organism, an obligate parasite, propagating only in the human intestinal tract and disseminated

by ingestion of excreta, was expressed by a number of contemporary writers ; but seldom if ever was the whole idea expressed, and no one else followed it through to such full development. That Snow's contemporaries considered his theory of cholera to be original is evidenced by the fact that they referred to it as "Dr. Snow's theory" and, in their discussions, differentiated it from all the other theories which it was customary to mention.

The extent to which the ideas and evidence advanced by Snow were to be accepted in his lifetime is foreshadowed in this passage from his own first paper on cholera (1849):

Many medical men to whom the above circumstances respecting the water have been mentioned, admit the influence of the water, without admitting the special effect of the new element introduced into it—viz., the cholera evacuations, in communicating the disease. They look upon the bad water as only a predisposing cause, making the disease more prevalent amongst those who use it—a view which, in a hygienic sense, is calculated to be to some extent as useful as the admission of what I believe to be real truth, but which, I think, will be found to be untenable, when the circumstances are closely examined.

After Snow's evidence convicting the water supply of the Southwark and Vauxhall Company had been published, none but the most stubborn could deny the influence of contaminated water. And when the

facts had been confirmed by the official inquiry which was completed in 1856, the case was not open to further argument. But what was accepted was merely the fact that impure water had, in some way, the effect of increasing the risk of cholera, and this had long been admitted by many. Snow's explanation of the fact was by no means accepted. Simon's report on the official inquiry which confirmed Snow's facts took pains to make this clear, coming to the conclusion that "under the specific influence which determines an epidemic period, fecalized drinking-water *and fecalized air equally* may breed and convey the poison."* Even Farr, who had immediately seen the significance of Snow's first observations, who had given whole-hearted aid in extending them, and who was destined himself to play the principal rôle in proving that the next epidemic of cholera in London (1866) was water-borne—even Farr gave only a qualified acceptance to Snow's explanation. Nearly twenty years later such an authority as Hirsch was still referring to contaminated water as a "predisposing cause" of cholera. Among English writers of distinction Budd seems to have stood nearly if not quite alone in prompt and unqualified acceptance of Snow's theory as well as his facts.

Any immediate influence which Snow's work may

* Report on the last two cholera epidemics of London as affected by the consumption of impure water ; addressed to the Rt. Hon. the President of the General Board of Health by the Medical Officer of the Board.

have had in promoting the improvement of public water supplies is obscured by the fact that extensive improvements in several of London's supplies, including that of the Southwark and Vauxhall Company, had already been ordered before the epidemic of 1853–54, to be effective within specified time limits. Nevertheless he did succeed in convincing his contemporaries that sewage pollution of drinking-water was a major rather than a minor factor in the conveyance of cholera. Thirty years later, when all controversy on this point had subsided, Sir John Simon, who, in Snow's lifetime, had stood aloof from him, classed his proof of this principle as “the most important truth yet acquired by medical science for the prevention of epidemics of cholera.”*

Snow lived only four years after the epidemic of 1854, and in this time he had no opportunity to add to his observations of cholera, which had disappeared from Great Britain. He continued, however, to pursue studies extending to other diseases two principles which he had established for cholera: the tremendous importance of water as a vehicle of specific infection, and the harmlessness—as regards infectious disease—of the “effluvia” from dead organic matter, which were so generally considered at the time to breed pestilence. For both these doctrines, especially the

* Simon, Sir John, *English sanitary institutions*, London, Cassell and Co., 1890, p. 262.

latter, he was severely criticized, but avoiding heated controversy, he sought facts. In 1858, in a paper on *Drainage and Water Supply in Connexion with the Public Health*, one of the last published in his lifetime, he deals with both subjects. Drawing upon the reports of the Registrar-General for his data, he first shows that among workers in the notoriously offensive trades, such as tanning and soap boiling, mortality rates are, in general, no higher than at corresponding ages in the whole group of industrially employed males. He then turns, by contrast, to the demonstrable relation between mortality and the sewage pollution of water. Presenting tables compiled from the Registrar-General's reports, he shows that prior to improvements in the water supply of the south districts of London, which were completed in the second quarter of 1855, the mortality rates from all causes, from typhus (mostly typhoid fever), and from diarrhoea in this area had consistently exceeded the rates in the districts north of the Thames. Dating from the change in water supply, this relationship was reversed, the rates of mortality being lower in the south districts than in the north. Here his work ended.

Of Snow's character, the circumstances of his life, the range of his interests, and the position which he held in his profession, an illuminating account is given in the memoir by Richardson, his warm friend and admirer. It gives the picture of a man singu-

larly endowed with the ability to think in straight lines and the courage to follow his own thought. In medicine these abilities placed him in the front ranks of his day ; in epidemiology they carried him a generation beyond it.

WADE HAMPTON FROST

JOHN SNOW, M.D.

A REPRESENTATIVE OF MEDICAL SCIENCE AND ART
OF THE VICTORIAN ERA

SIR BENJAMIN WARD RICHARDSON

1828–1896

M.A., M.D., LL.D., F.R.C.P., F.R.S. Lecturer in Public Hygiene, 1849, and in Physiology, 1857, Grosvenor Place School of Medicine. President, Medical Society of London, 1868. Croonian lecturer, 1873. Recipient of Fothergill gold medal awarded by Medical Society of London, 1854, and of Astley Cooper prize for an essay in physiology. Distinguished as a physician, physiologist, sanitarian, and a writer on medical history.

JOHN SNOW, M.D.

A REPRESENTATIVE OF MEDICAL SCIENCE AND ART
OF THE VICTORIAN ERA

BY B. W. RICHARDSON

THE Victorian Faculty of Physic has produced no one man of commanding genius who has remained in medicine, practising the art. It has, however, produced many truly representative men who, in their combined labours, offer a magnificent result of work done and advancement made. Amongst these I should place in the first rank the late Dr. John Snow, and for this reason I bring forward here a sketch of his career for the student of the future.

John Snow was born at York, on June 15th, 1813. He was the eldest son of his parents. His father was a farmer. As a child he showed his love of industry, and increasing years added only to the intensity with which he applied himself to any work that was before him. He was first sent to a private school at York, where he learned all that he could learn there. He was fond of the study of mathematics, and in arithmetic became very proficient. At the age of fourteen he went to Newcastle-on-Tyne, as an articled pupil to Mr. William Hardcastle, surgeon, of that place. He had also the opportunities of studying at the Newcastle Infirmary. During the third year of his apprenticeship, when he was seventeen years old, he formed an idea that the vegetarian system of feeding was the true and the old; and with a consistency which throughout

NOTE: This article was first published in *The Asclepiad*, London, 1887, Vol. IV, 274-300.

life attended him, tried the system rigidly for more than eight years. He was a noted swimmer at this time, and could make head against the tide longer than any of his omnivorous friends.

At or about the same time that he adopted his vegetarian views, he also took up the temperance cause. He not only joined the ranks of the total abstinence reformers, but became a powerful advocate of their principles for many succeeding years. In the latter part of his life he occasionally drank a little wine, but his views on the subject remained to the end unchanged. He retained a strong faith in total abstinence, and a belief that it must ultimately become universal.

In 1831-32 cholera visited Newcastle and its neighbourhood, and proved terribly fatal. In the emergency Mr. Snow was sent by Mr. Hardcastle to the Killingworth Colliery, to attend the many sufferers from the disease. In this labour he was indefatigable, and his exertions were crowned with great success. He made also various observations relating to this disease, which proved to him of immense account in after-years.

He left Newcastle in 1833, and engaged himself as assistant to Mr. Watson, of Burnop Field, near Newcastle, with whom he resided for twelve months. Leaving Burnop Field in 1834-5, he revisited his native place, York, for a short stay, and thence to a certain half-inaccessible village called Pately Bridge, in Yorkshire, to act as assistant to Mr. Warburton, surgeon of that place. Eighteen months at Pately Bridge, with many rough rides, a fair share of night work, a good gleaning of experience, and, this sojourn over, our student went back again to York, to remain a few months, and to take an active share in the formation of temperance societies. In leisure days during this period it was his grand amusement to make long walking explorations into the country, collecting all kinds of in-

formation,—geological, social, sanitary, and architectural.

At last York must again be left for the London student life was in view. In the summer of 1836 he set off from York to Liverpool, and, trudging it afoot from Liverpool through the whole of North and South Wales, turned London-ward, calling at Bath by the way, on a visit to his uncle, Mr. Empson, to whom, to the end of his life, he was devotedly attached. October 1836—eventful October—brought him to the “great city,” and placed him on the benches of the Hunterian School of Medicine in Windmill Street; a school long since closed, and now as mythical as the mill which gave the name to the locality.

In October 1837 Mr. Snow began to take out his hospital practice at the Westminster Hospital. On May 2nd, 1838, he passed his examination, and was entered duly as a member of the Royal College of Surgeons of England. In October 1838 he passed the Apothecaries’ Hall, and was now duly qualified in medicine. His student days were passed at 11, Bateman’s Buildings, Soho Square.

At this time there existed in London a society (now the “Medical Society of London”), called the “Westminster Medical Society.” It was a society which had long given encouragement to those junior members of the medical profession who might wish for a hearing at its meetings and debates. Mr. Snow was not the man to lose an opportunity such as this. I have often heard him say, both privately and publicly, that, upon his early connection with the “Westminster Medical,” his continuance in London depended, and all his succeeding scientific success. When he first attended the meetings of the “Westminster Medical,” he was very timid; and although he always spoke to the point, he found it difficult to obtain a favourable notice. At first nobody ever replied to what he said. After a long time some grave counsellor condescended to refer to him as the “last speaker.” A little

later and somebody ventured to name “ the last speaker ” by his name. Then some one, bolder still, concurred with Mr. Snow ; and ultimately Mr. Snow became recognised more and more, until the presidential honours were his own.

Frith Street, Soho-square, No. 54, was the house at which Mr. Snow, to use his own words, “ first nailed up his colours.” He removed there from Bateman’s Buildings in September 1838. He bought no practice, nor exhibited any pretence, but a more thoroughly girded man for the world’s encounter could hardly be conceived than he at this time. He took no wine nor strong drink ; he lived on anchorite’s fare, clothed plainly, kept no company, and found every amusement in his science books, his experiments, and simple exercise.

To fill up time till the money patients should come, he became one of the visitors of the out-patients of Charing Cross Hospital, and to many a representative of the great poor he extended a skill which would have been a blessing to the great rich. The librarian of the College of Surgeons’ Library considered him a quiet man, who read closely, and was not too proud to ask for a translation when an original bothered him. All who knew him said he was a quiet man, very reserved and peculiar—a clever man, but not easy to be understood, and very peculiar.

The connection with the “ Westminster Medical ” led to Mr. Snow’s first attempts at authorship. On October 16th, 1841, he read at the Society a paper on “ Asphyxia and on the Resuscitation of New-born Children.” The paper in full will be found in the *London Medical Gazette* for November 5th of the same year. The paper is remarkable for the soundness of its reasonings and the advanced knowledge which it displays. The object of the paper was to introduce to the Society a double air-pump, for supporting artificial respiration, invented by Mr.

Read of Regent Circus. The instrument was so devised that by one action of the piston the air in the lungs could be drawn into one of the cylinders, while by the reverse action the expired air could be driven away, and the lungs supplied with a stream of pure air from the second cylinder. There was also advanced, in the concluding part of the communication, the view that the cause of the first inspiration is probably the same as the second or the last, viz., a sensation or impression arising from a want of oxygen in the system. So long as the placenta performs its functions, the foetus is perfectly at ease, and feels no need of respiration ; but whenever this communication between the child and its mother is interrupted, at least in the later months of pregnancy, the child makes convulsive efforts at respiration similar to those made by a drowning animal.

On December 18th, 1841, Mr. Snow was again before the “ Westminster Medical ” with a very ingenious instrument which he had invented for performing the operation of paracentesis of the thorax. The description of the instrument will be found in the *Medical Gazette* of January 28th, 1842.

In the *Medical Gazette* for November 11th, 1842, Mr. Snow published a note on a new mode for securing the removal of the placenta in cases of retention with hæmorrhage ; and in the same journal for March 3rd, 1843, he communicated an essay on the circulation in the capillary vessels. The essay was selected and re-arranged from papers read before the “ Westminster Medical ” on January 21st and February 4th. We have in this essay an admirable sketch of the capillary circulation. He advanced, on this occasion, the idea that the force of the heart is not alone sufficient to carry on the circulation, but that there is a force generated in the capillary system which assists the motion. He explained also the great importance of the

cutaneous exhalation, and reasoned that in febrile states, accompanied with hot skin, the transpiration from the skin is in reality greater than it is in health.

Pushing on in the higher branches of his profession, and aiming always at the best, the degree of the University of London became a temptation, and *Mr.* became *Dr.* Snow on the 23rd of November, 1843, by passing the M.B. examination. He was enrolled in the second division on this occasion. On the 20th of December in the following year, he passed the M.D. examination, and came out in the first division.

The harass of London life by this time commenced to tell on Dr. Snow. He had suffered a few years previously from threatened symptoms of *Phthisis pulmonalis*, but took plenty of fresh air and recovered. He again became unhinged for work, and in the summer of 1845, was attacked with acute and alarming symptoms of renal disorder. His friend and neighbour, Mr. Peter Marshall, then of Greek Street, afterwards of Bedford Square, gave him his able assistance, and the advice of Dr. Prout and of Dr. Bright was obtained. In the autumn of 1845 he paid a visit to his old colleague, Mr. Joshua Parsons, at Beckington. From Beckington he went to the Isle of Wight, but soon returned to London and was elected Lecturer on Forensic Medicine at the Aldersgate School of Medicine, an appointment held till the school ceased in 1849.

There is no night without its morning. The eventful medical year of 1846 proved the turn of tide season for our struggling Esculapian. In this year the news came over from America that operations could be painlessly performed under the influence of ether.

The fact was just such an one as would at once attract the earnest attention of Dr. Snow. It was a physiological, as well as a practical fact. It was rational in its meaning,

and marvellously humane in its application. The question, once before him, was in a scientific sense his own. His previous experimental studies on respiration and asphyxia had prepared him for this new inquiry ; he took it up for its own sake and not from any thought, at the time, of a harvest of gold.

The first inhalations of ether in this country were not so successful as to astonish all the surgeons, or to recommend etherisation as a common practice. The distrust arose from the manner in which the agent was administered. Dr. Snow at once detected this circumstance ; and remedied the mistake by making an improved inhaler. He next carried out many experiments on animals and on himself, and brought the administration to great perfection. One day, on coming out of one of the hospitals—I am giving the narrative as he gave it to me—he met a druggist whom he knew bustling along with a large ether apparatus under his arm. “ Good morning ! ” said Dr. Snow. “ Good morning to you, doctor ! ” said the friend ; “ but don’t detain me, I am giving ether here and there and everywhere, and am getting quite into an ether practice. Good morning, doctor ! ” Rather peculiar ! said the doctor to himself ; rather peculiar, certainly ! for this man has not the remotest physiological idea. An “ ether practice ! If he can get an ether practice, perchance some scraps of the same thing might fall to a scientific unfortunate.” Consequently, with his improved inhaler, Dr. Snow lost no time in asking to be allowed to administer ether to the out-patients at St. George’s Hospital, in cases of tooth-drawing. Dr. Fuller, of Manchester Square, standing by, was surprised to see with what happy effects ether was administered when administered properly. A day or two afterwards, a major operation having to be performed, and the surgeon, Mr. Cutler, not approving of the ether in the way in which it had previously acted, Dr. Fuller

remarked on the superiority of Dr. Snow's mode of administering it ; and the result was, that he was asked to give it on operating days. He did so with great success. He administered it also at University College with the same success. Liston, then the leading operator, struck with the new man, able as unaffected, took him by the hand ; and from that time the ether practice in London came almost exclusively to Dr. Snow.

The new field once open, it were impossible but that he should cultivate it diligently. The Westminster Medical Society was often favoured with his communications and experiments on etherisation ; and in the September of 1847 he embodied, in his first work, the whole of his experience up to that time. The work was remarkable for the care with which it was written, and the complete mastery of the subject which it conveyed.

What had been a mere accidental discovery, I had almost said a lucky adventure, was turned by the touch of the master into a veritable science. The book was beginning to be appreciated when the discovery of the application of chloroform threw ether into the shade, and the book with it.

Dr. Snow, though a man of great firmness when once his mind was made up, was always ready for new inquiry. Chloroform, therefore, was no sooner brought before the profession by Dr. Simpson, than he began to institute a series of independent researches, and having satisfied himself personally as to the effects and greater practicability of chloroform, he at once commenced its use, and forgot sooner than most others his predilections for ether. In 1848, he commenced a series of experimental papers on narcotic vapours in the *Medical Gazette*, and continued them until 1851, when the *Medical Gazette* ceased to exist independently. The papers on narcotics, in accordance with his other and earlier productions, were stamped with

the evidences of profound and careful research, and still more careful deduction. I infer that they have been more talked about than read, for few people seem to be aware of the enlarged and original physiological arguments which they contain. Chloroform and ether are not alone discussed, but all narcotics. Narcotics are not alone considered, but various of the great functions of life. The records of a vast number and variety of experiments are here related, and an amount of information, original in kind, collected, which will always remain as a memorable record in the history of medical literature. But the great points in these papers are those in which the author enters on the physiological action of narcotics. Here appear the generalisations and insights into the relations of allied phenomena which mark the man of true power.

The year of the world's fair in London, 1851, may be considered a fortunate one for Dr. Snow. His affairs had taken a new turn, and the tide was fairly in his favour. He had a positive holiday, physical and mental. The harass of the professional struggle was over, the world was opening its eyes to his intrinsic merits; old friends, brought to the grand show in town, flocked around him, and all was well. He did but little that was new this year, except to write a characteristic letter to Lord Campbell, who was pushing on a Bill in the House of Lords, called the "Prevention of Offences Bill," in which a clause was introduced to prevent, by severe punishment, any attempt that might be made by any person to administer chloroform or other stupifying drug for unlawful purposes. Dr. Snow, believing that Lord Campbell was actuated in introducing this clause by the fact that certain trials having recently occurred for the offence of using chloroform unlawfully, and being himself convinced that, in two of the cases, one the case of a robbery in Thrale Street, the other, of a robbery attempted on London Bridge, the evi-

dence against the prisoners, of attempting to produce insensibility by chloroform, was without any reason or possibility, he opposed the afore-named clause in the Bill, on the ground that, if it became law, numerous frivolous and false charges would be constantly brought up against innocent people, or against guilty persons, but persons not guilty of the special charge laid against them, that, namely, of administering a volatile narcotic by inhalation. Knowing that weakness of human nature which leads a man, in the presence of all evidence, never to admit intoxication as possible in his own proper person, Dr. Snow felt that, in any case where an intoxicated person had been robbed, such person might allege that he had been made insensible by narcotic vapour. The two cases specially noticed in his letter admitted readily of such interpretation, and were clearly not cases in which chloroform had been administered. Lord Campbell, on the receipt of Dr. Snow's letter, referred to it in very complimentary terms in the Lords, but intimated that the reasoning of the letter did not alter his determination.

In the year 1848 Dr. Snow, in the midst of his other occupations, turned his thoughts to the questions of the cause and propagation of cholera. He argued in his own mind that the poison of cholera must be a poison acting on the alimentary canal by being brought into direct contact with the alimentary mucous surface, and not by the inhalation of any effluvium. In all known diseases, so he reasoned, in which the blood is poisoned in the first instance, there are developed certain general symptoms, such as rigors, headaches, and quickened pulse; and these symptoms all precede any local demonstration of disease. But in cholera this rule is broken; the symptoms are primarily seated in the alimentary canal, and all the after-symptoms of a general kind are the results of the flux from the canal. His inference from this was, that the poison of cholera is

taken direct into the canal by the mouth. This view led him to consider the media through which the poison is conveyed, and the nature of the poison itself. Several circumstances lent their aid in referring him to water as the chief, though not the only, medium, and to the excreted matters from the patient already stricken with cholera, as the poison. He first broached these ideas to Drs. Garrod and Parkes, early in 1848; but feeling that his data were not sufficiently clear, he waited for several months, and having in 1849 obtained more reliable data, he published his views *in extenso* in a pamphlet, entitled "The Mode of Communication of Cholera." During subsequent years, but specially during the great epidemic outbreak of the disease in London in 1854, intent to follow out his grand idea, he went systematically to his work. He laboured personally with untiring zeal. No one but those who knew him intimately can conceive how he laboured, at what cost, and at what risk. Wherever cholera was visitant, there was he in the midst. For the time he laid aside as much as possible the emoluments of practice; and when even, by early rising and late taking rest, he found that all that might be learned was not, from the physical labour implied, within the grasp of one man, he paid for qualified labour. The result of his endeavours, in so far as scientific satisfaction is a realisation, was truly realised, in the discovery of the statistical fact, that of 286 fatal attacks of cholera, in 1854, occurring in the south districts of the metropolis, where one water company, the Southwark and Vauxhall, supplied water charged with the London fæcal impurities, and another company, the Lambeth, supplied a pure water, the proportion of fatal cases to each 10,000 houses was to the Southwark and Vauxhall Company's water 71, to the Lambeth 5.

There was, however, another fact during this epidemic, which more than the rest drew attention to Dr. Snow's

labours and deductions. In the latter part of August 1854, a terrific outbreak of cholera commenced in and about the neighbourhood of Broad Street, Golden Square. Within two hundred and fifty yards of the spot where Cambridge Street joins Broad Street, there were upwards of five hundred fatal attacks of cholera in ten days. To investigate this fearful epidemic was at once the self-imposed task of Dr. Snow. On the evening of Thursday, September 7th, the vestrymen of St. James's were sitting in solemn consultation on the causes of the visitation. They might well be solemn, for such a panic possibly never existed in London since the days of the great plague. People fled from their homes as from instant death, leaving behind them, in their haste, all which before they valued most. While, then, the verstrymen were in solemn deliberation, they were called to consider a new suggestion. A stranger had asked, in modest speech, for a brief hearing. Dr. Snow, the stranger in question, was admitted, and in few words explained his view of the "head and front of the offending." He had fixed his attention on the Broad Street pump as the source and centre of the calamity. He advised the removal of the pump-handle as the grand prescription. The vestry was incredulous, but had the good sense to carry out the advice. The pump-handle was removed, and the plague was stayed. It was my privilege, during the life of Dr. Snow, to stand on his side. It is now my duty, as a biographer who feels that his work will not be lost, to claim for him not only the entire originality of the theory of the communication of cholera by the direct introduction of the excreted cholera poison into the alimentary system; but, independently of that theory, the entire originality of the discovery of a connection between impure water supply and choleraic disease. The whole of his inquiries in regard to cholera were published in 1855, in the second edition of his work on the "Mode of Com-

munication of Cholera"—a work in the preparation and publication of which he spent more than £200 in hard cash, and realised in return scarcely so many shillings.

In 1856, he made a visit to Paris in company with his uncle, Mr. Empson, who having personally known the emperor many years, had on this occasion special imperial favours shown to him, in which the nephew participated. During the visit Dr. Snow lodged a copy of his work on Cholera at the "Institute," in competition for the prize of £1,200 offered for the discovery of a means for preventing or curing the disease. The decision of the judges has since been published, but with no notice of Dr. Snow's researches.

The Medical Society of London, reformed under that name in 1849-50, by amalgamation with the Westminster Medical, was at this time the principal scene of Dr. Snow's scientific exertions. In 1852, the Society elected him as Orator for the ensuing year; and at the eightieth anniversary of the Society, held on March 8th, at the Thatched House Tavern, he delivered an admirable oration on "Continuous Molecular Changes, more particularly in their Relation to Epidemic Diseases." He made no claim to the orator's gown; but the address was too forcible not to call forth the enthusiasm of the audience. He spent nearly twelve months in the preparation of this oration, in which he endeavoured to convey, in the most pleasing manner at his command, a broad view of his observations on the communication of certain spreading diseases. He advanced, on this occasion, the idea that the poison of intermittent fever, and perhaps yellow fever, is carried direct, like the poison of cholera, into the alimentary system.

Two years after this event, having, meantime, passed the office of vice-president, the Society elected him to the highest honour it can confer,—to the presidential chair.

He took his place as President, in his unassuming manner, on March 10th, 1855, delivering a short address. Throughout the year he carried out the duties of his office with great success. One of his presidential acts was peculiarly graceful. One evening, while presiding, Dr. Clutterbuck—then the father, or oldest member of the Society—came into the meeting. The venerable and distinguished old man, then long past his eightieth year, had lately been a stranger to the assembly, and was known but to few of the members. The President, as Dr. Clutterbuck entered the room, rose, and in a way that was irresistible in its simple courtesy resigned his chair to the veteran Esculapian. “It is near fifty years,” said Dr. Clutterbuck with emotion, as he took the proffered seat, “since I last occupied this honourable position.” At the next anniversary meeting, held on March 8th, 1856, Dr. Clutterbuck came to his last meeting, and to see his friend the President play also his last part in presidential duties. At the anniversary dinner on that same day, the President reviewed, in feeling terms, his own career in the professional strife, and expressed that his success in life had originated in his acquaintance with the Society.

In addition to the fellowship of the Medical Society, Dr. Snow belonged to the Royal Medical and Chirurgical, Pathological, and Epidemiological societies, and to the British Medical Association. The Medical Society, from its old associations, was, however, that in which he took the most active part. Next to this, the Epidemiological Society, founded by the late Mr. Tucker, of Berners Street, claimed his regard.

The position which he took as an epidemiologist was original, and in opposition to the views of many eminent men who had, in matters relating to public health, considerable scientific and political influence.

He contended, in regard to true epidemic disorders,

distinguished by specific symptoms, that they are due to a specific poison, which is propagated by certain fixed laws ; which attains its progression and increase in and through animal bodies ; which is communicated from one animal body to another ; and, which is the same in its essence from first to last. This was his position, and he adhered to it. No mere emanation arising from evolution of foul smelling gases can, *per se*, according to his views, originate a specific disease, such as small-pox or scarlet fever ; as well expect that the evolution of such gases should plant a plain with oaks or a garden with crocuses. The small-pox may occur over a cesspool as an oak may spring up through a manure heap ; but the small-pox would never appear over the cesspool in the absence of its specific poison ; nor the oak rise from the manure heap in the absence of the acorn which seeded it.

In 1855 Dr. Snow gave evidence before the select committee on the “Public Health and Nuisances Removal Bill,” in which evidence he strove to convey the impressions condensed above. Feeling that he had not been correctly understood, he afterwards wrote a letter to Sir Benjamin Hall, in which he set forth the whole of his argument very distinctly and sensibly. He indicated in this letter that he was no defender of nuisances, but that whereas a bad smell cannot, simply because it is a bad smell, give rise to specific disease, so an offensive business conducted in a place where it ought not be, should be proceeded against by ordinary law as a nuisance, without applying to it the word pestiferous, or otherwise dragging in and distorting the science of medicine.

In relation to public health Dr. Snow contributed many other observations. In the first number of my *Journal of Public Health and Sanitary Review*, he communicated a valuable paper, previously read at the Epidemiological Society, on the “Comparative Mortality of Town and

Rural Districts ; ” and, previous to his decease, he was busily occupied in investigating the question of adulteration of bread with alum. He made several analyses of different specimens of bread, but his papers merely leave a brief record of the fact, without any comments or results.

I return for a few moments to some further points connected with his researches on inhalation. In addition to his experiments with volatile narcotics, he carried out for a long time a series of inquiries with other medicinal substances, and administered many remedies by inhalation at the Brompton Hospital, during a period of twenty months. In 1851, he recorded the result of this experience at the Medical Society of London, and explained the modes of administering various agents. Some, as morphia and stramonium, were inhaled with the aid of heat ; others, as hydrocyanic acid and conia, were inhaled at the ordinary temperature. The particulars of these experiments will be found in a short paper in the *London Journal of Medicine* for January 1851.

He continued steadily to investigate the effects of various volatile agents for the production of insensibility, performing a variety of experiments with carbonic acid, carbonic oxide, cyanogen, hydrocyanic acid, Dutch liquid, ammonia, nitrogen, amylovinic ether, puff-ball smoke, allyle, cyanide of ethyle, chloride of amyl, a carbo-hydrogen from Rangoon tar, a carbo-hydrogen coming over with amylene, and various combinations of these. His grand search was for a narcotic vapour which, having the physical properties and practicability of chloroform, should, in its physiological effects, resemble ether in not producing paralysis of the heart.

First he ascertained the boiling-point of the substance under investigation ; then the point of saturation of air with the vapour at different temperatures ; next the effects of inhalation of the vapour by inferior animals ; and finally

the quantity required to be inspired, with the air breathed, to produce insensibility. When he had obtained any substance which would produce insensibility favourably on animals, he pushed it, in one or two experiments, to its extreme in animals of different kinds. Then having produced death by the inhalation, both by giving rapidly a large dose, and by giving a small dose for a long period, he observed the mode of death, whether it occurred primarily by cessation of the heart, or by cessation of the respiration. If the agent seemed to promise favourably from these inquiries, he commenced to try it on man ; and the first man was invariably his own self. His friends, knowing his unflinching courage in the ardour of his inquiries, often expostulated with him in regard to the risks he ran. It was of no avail. He felt the personal trial a duty, and he did it. I do not believe, as some have supposed, that these personal experiments had any effect in producing his early death ; but it is certain that he underwent many risks in the performance of his investigations, and that he held his own life of least value when the lives of others were under consideration.

There is yet another trait in his character which I cannot but notice, and which I would respectfully commend to all physiological inquirers. While he held it as a necessity to use inferior animals for the purpose of experiment, he never touched living thing with the physiologist's finger without having before him some definite object ; and never performed experiment on any animal without providing with scrupulous care against the infliction of all unnecessary suffering. The interests of humanity were, he thought, best advanced by the universal practice of humanity.

By his earnest labours Dr. Snow soon acquired a professional reputation, in relation to his knowledge of the action of anæsthetics, which spread far and wide, and the

people, through the profession, looked up to him from all ranks, as the guide to whom to entrust themselves in "Lethe's walk." On April 7th, 1853, he administered chloroform to Her Majesty at the birth of the Prince Leopold. A note in his diary records the event. The inhalation lasted fifty-three minutes. The chloroform was given on a handkerchief, in fifteen minim doses ; and the Queen expressed herself as greatly relieved by the administration. He had previously been consulted on the occasion of the birth of Prince Arthur, in 1850, but had not been called in to render his services. Previous to the birth of Prince Leopold he had been honoured with an interview with His Royal Highness the Prince Albert, and returned much pleased with the Prince's kindness and great intelligence on the scientific points which had formed the subject of their conversation. On April 14th, 1857, another note in the diary records the fact of the second administration of chloroform to Her Majesty, at the birth of the Princess Beatrice. The chloroform again exerted its beneficent influence, and the Queen once more expressed her satisfaction.

Inquisitive folk often overburthened Snow, after these events, with a multitude of questions of an unmeaning kind. He answered them all with good-natured reserve. "Her Majesty is a model patient," was his usual reply : a reply which, he once told me, seemed to answer every purpose, and was very true. One lady of an inquiring mind, to whom he was administering chloroform, got very loquacious during the period of excitement, and declared she would inhale no more of the vapour unless she were told what the Queen said, word for word, when she was taking it. "Her Majesty," replied the dry doctor, "asked no questions until she had breathed very much longer than you have ; and if you will only go on in loyal imitation, I will tell you everything." The patient could not but fol-

low the example held out to her. In a few seconds she forgot all about Queen, Lords, and Commons ; and when the time came for a renewal of hostilities, found that her clever witness had gone home, leaving her with the thirst for knowledge still on her tongue.

From the literary and medical history of Dr. Snow, let me turn for a few pages to his history personal as I knew him. He was of middle height, of somewhat slender build, and of sedate expression. His long life in comparative student loneliness had made him reserved in manner to strangers ; but with private friends he was always open, and of sweet companionship. With his increased popularity he became less reserved to strangers, and in the last years of his life he so far threw off restraint as to visit the opera occasionally. But he moderated every enjoyment, and let nothing personal stand in the way of his scientific pursuits. He was the impersonation of order. He had his time and place for everything. He kept a diary, in which he recorded the particulars of every case in which he administered chloroform or other anæsthetic, with comments on the results of the administration, and hints as to dangers avoided or chanced. He kept a record of all his experiments and short notes of observations made by his friends. He rose early and retired early to rest,—at eleven o'clock. He seemed, whenever he was waited on, as though he had nothing in hand, and was always open to an engagement.

Anything and everything of scientific interest that arrested his attention aroused his enthusiasm and his desire to be of use. When I was living at Mortlake, he would run down, on request, after his day's duties were over, to a *post-mortem*, to see a poor patient, or to take part in an experiment, returning as cheerily as though he had received the heaviest fee. This is but one example of his kindly nature.

He laid no claim to eloquence, nor had he that gift. A peculiar huskiness of voice, indeed, rendered first hearings from him painful ; but this was soon felt less on acquaintance, and the ear once accustomed to the peculiarity, the mind was quickly interested in the matter of his discourse, for he always spoke earnestly, clearly, and to the point. In the Societies he spoke very often, and gave expression to views, on which he had spent great thought, with a generous freedom which, in so far as the fame of his originality was concerned, had been better held in reserve. It had been better, that is to say, for him to have carefully elaborated some of his views in the closet, and published them fully, than to have sent them forth in the hurry of debate. Had he lived, he would possibly have collected many stray labours thus put forward, and have given to them the matured consideration which they deserved. One of his views, on which he would have bestowed great attention, refers to the origin of various morbid growths, such as cancer. He believed that these morbid formations are all of local origin ; that they arise in the parts of the body where they are found, from some perversion of nutrition ; and that the constitutional effects are secondary to, and dependent on, the local disorder. He made many observations on this important subject, notices of which are to be found scattered, here and there, in the proceedings of the Medical Society of London, but no connected record was ever completed.

His private conversation was both instructive and amusing ; he was full of humorous anecdotes, which he told in a quiet and irresistibly droll style.

His replies, when under the fire of cross-question, were ready and common-sense. Once, as we have already told, he observed that sulphuric ether is safer than chloroform. "Why, then," said a listener, "do you not use ether?" "I use chloroform," he resumed, "for the same reason

that you use phosphorus matches instead of the tinder box. An occasional risk never stands in the way of ready applicability." On another occasion, after one of the meetings of the "Medical Society," when the subject of a specific cholera cell had been under debate, some one asked him, as a poser and rather ironically, where he thought the first cholera cell came from? "Exactly," he replied, with a shrewd look. "But to begin, do you tell *me* where the first tiger or the first upas tree came from; nay, tell me where you came from yourself, and I will then tell you the origin of the first cholera cell, and give you the full history of the first case; but I want a model before I venture on the description of ultimate facts."

As an author his style was plain, clear, and smoothly elegant. His argument was always carefully studied and carefully rendered. He sent manuscript to the printer which required scarcely a letter of correction. Both in writing and speaking he made the expression of truth his first business. Neither provocation nor temptation could ever lead him aside from that principle. His readings were select. He chiefly read scientific works, old and new. He had great relish for some of the old medical writers—the masters in physic. He had read Bacon, but agreed with Harvey's criticism that Bacon wrote science like a lord chancellor. He had a notion that there had been a history long previous to any we know of from existing records, in which the sciences generally had risen to a greater perfection than they are at this present. His conversance with Sprengel's "History of Medicine" had possibly led him to this opinion. He was fond of general history also, but studied it little. He never read novels, because the hours devoted to them were, he felt, hours thrown away. At the same time he enjoyed as much as any man ridiculous life-pictures naturally cast. When he came to see me, and leisure was with us, I often read to him some of

the more amusing passages from Dickens and Thackeray, or from one of the older writers, as Swift. It was a new world to him, and provoked great fun. He would ask to have passages read over again, that he might better realise the conception. He himself observed human character shrewdly, and described it in its humorous phases so well that if he had written as he related he would have ranked as one of the great humorists of the age.

He thought severely of the reviewer's art, and would never of late review any book critically. If a book were good, it carried the review of its own merits. If it were bad, it were better left untouched. He, at all events, with so much original work before him, could not stop to criticise his compeers or their transactions. Let the dead bury their dead; he must march with the living while life gave power.

He admired art, and felt real pleasure in advancing it. He enjoyed innocent recreations, and was ever at home in the family circle. He had his regrets that he had never married, the fates had been against him permanently on that score. He loved the prattle and gaiety of children. When he went to court, arrayed in his court suit, nothing connected with the event delighted him so much as the saying of the child of a friend, who, on seeing him start, with his sword and flattened hat, held up her hands, and exclaimed, "Oh! isn't Dr. Snow *pretty*, mamma." The idea of being considered pretty roused in him quite a new and droll sensation, which he could not help repeating as a rare incident in a courtier's career. The anecdote is simple, but it gives a good idea of the genial and gentle nature of the man.

It has been shown that the tendency of Dr. Snow's mind for philosophical pursuits led him away in some measure from the practical drudgery of professional life. From this fact it has been too hastily inferred that he was there-

fore, in the common parlance, “ not a practitioner.” Those who knew him as a practitioner, and had reaped the advantage of his assistance in cases of doubt or difficulty, had a very different opinion. These, with one accord, spoke of him, as having been, without any ostentation, one of the soundest and most acute of our modern physicians. He had great tact in diagnosis ; an observant eye, a ready ear, a sound judgment, a memory admirably stored with the recollection of cases bearing on the one in point ; and a faculty of grouping together symptoms and foreshadowing results, which very few men have possessed. For my part, I can bear truthful testimony to his eminent qualities as a practitioner, and to the fact that his philosophical labours only served to render him more intelligent and profound in matters relating to diseases and their treatment.

And, when the opportunity offered for obtaining remunerative practice by the exercise of true scientific skill, Snow showed himself, both in act and industry, competent for success. He soon overcame all difficulties, and managed by his frugality to lay in store for a rainy day for himself, and to help such friends as needed. Many rumours as to the extent of his gains abounded which it is right to correct. His largest income was £1,000 a year ; it never exceeded that sum. For this he administered chloroform or other anæsthetic about four hundred and fifty times annually, taking an average of ten years preceding his death. In many cases his services were gratuitously supplied.

In his private relations Dr. Snow was a man of the strictest integrity and purest honour. The experiences of life, instead of entwining around him the vices of the world, had weaned him from the world. Without any pretence, maintaining no connection with sect or party, he carried out a practical religion, independently of any hypothesis or abstruse profession, which few professors

could approach. A child of nature, he knew no way of recognising the Divine influences so purely as in silent and inexpressible admiration of those grand external phenomena which each moment convey, to men of his character, the direct impression of a Power all-present and revealing itself for ever.

We approach the end. In the midst of his success, when medicine most valued him and his hand was most powerful, he stood one day in his mental strength, and the next day fell. Death found him at his duty.

On the morning of June 9th, 1858, while at work at the MSS. of his last book, "On Chloroform and Other Anæsthetics," he was seized suddenly with paralysis just as he had written the word "*exit* ; " and on June 17th, at 3 p.m., he slept the euthanasia. He was buried in Brompton Cemetery, and over his grave a few of us who knew him best erected a simple memorial.

For John Snow, as a representative man of medicine of the Victorian era, we may claim the poetic thought, less the poetic expression, combined with industry, perseverance, and the courage to express his own opinions boldly when founded on what he honestly felt to be the truth, and, if not the whole truth, nothing but the truth.

He had a patience that was inexhaustible, a devotion for labour unsurpassed, and a slow but sure and reliant comprehension and comprehensiveness which were not easily seen because of their extent. He combined with a stolid firmness distinctively Saxon a rare talent for penetration into obscure problems, for casting aside objects which are coincident or accidental, and for seizing determinately the realities for which he sought.

These attributes, if they do not constitute genius, consecrate life ; and, represented by and through a man, a family, or a nation, make the choicest history of the grandest eras.

ON THE MODE OF COMMUNICATION
OF CHOLERA

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CHOLERA.

BY

JOHN SNOW, M.D.,

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ROYAL MED. AND CHIR. SOCIETY, FELLOW AND VICE-
PRESIDENT OF THE MEDICAL SOCIETY
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M.DCCC.LV.

PREFACE TO THE SECOND EDITION.

THE first edition of this work, which was published in August 1849, was only a slender pamphlet. I have, since that time, written various papers on the same subject, which have been read at the Medical Societies, and published in the medical journals. The present edition contains the substance of all these articles, together with much new matter, the greater part of which is derived from my own recent inquiries.

I take this opportunity of expressing my thanks to the Registrar-General for the facilities afforded me in making these inquiries.

I feel every confidence that my present labours will receive the same kind consideration from the Medical Profession which has been accorded to my former endeavours to ascertain the causes of cholera.

Sackville Street, Piccadilly,
11 December, 1854.

CONTENTS.

	PAGE
Outline of the history of cholera	1
Cases proving its communication from person to person	3
Cholera not communicated by means of effluvia	9
The pathology of cholera indicates the manner in which it is communicated	10
Analysis of the blood and evacuations in cholera	11 and 14
Cholera is propagated by the morbid poison entering the alimentary canal	15
Evidence of this mode of communication in the crowded habi- tations of the poor	17
————— amongst the mining population	19
Instances of the communication of cholera through the medium of polluted water, in Horsleydown	23
————— at Albion Terrace, Wandsworth Road	25
————— at Ilford and near Bath	32
————— at Newburn on the Tyne	33
————— at Cunnatore	35
————— in the Black Sea Fleet	36
————— in the neighbourhood of Broad St., Golden Sq.	38
————— at Hampstead West End (the water being car- ried from Broad Street)	44
Explanation of the Map showing the situation of the deaths in and around Broad Street, Golden Square	45
Table of attacks and deaths near Golden Square	49
Outbreak of cholera at Deptford caused by polluted water	55
Communication of cholera by means of the water of rivers which receive the contents of the sewers	56
Influence of the water supply on the epidemic of 1832, in London	57

	PAGE
Table showing the mortality from cholera, and the water supply	58
Influence of the water supply on the epidemic of 1849, in	
London	60
Table showing this influence	62
Communication of cholera by Thames water in the autumn	
of 1848	66
New water supply of the Lambeth Company	68
Effect of this new supply in the epidemic of autumn 1853	69
Tables showing this effect	71 and 73
Intimate mixture of the water supply of the Lambeth with	
that of the Southwark and Vauxhall Company	74
Opportunity thus afforded of gaining conclusive evidence of	
the effect of the water supply on the mortality from cholera	75
Account of inquiry for obtaining this evidence	77
Result of the inquiry as regards the first four weeks of the	
epidemic of 1854	79
————— the first seven weeks of the same epidemic	82
Tables illustrating these results	84, 85
Inquiry of the Registrar-General respecting the effect of the	
water supply of the above-mentioned Companies during	
the later period of the epidemic	87
Comparison of the mortality of 1849 and 1854, in the districts	
supplied by the above-named Companies	89
Effect of the water supply on the mortality from cholera	
amongst the inmates of workhouses and prisons	91
Cholera in the district of the Chelsea Water Company	93
Effect of dry weather to increase the impurity of the Thames	95
Relation between the greater or less mortality from cholera	
in London and the less or greater elevation of the ground	97
This relation shown to depend on the difference of water supply	
at different elevations	<i>ib.</i>
Effect of water supply on the mortality of cholera in Birming-	
ham, Leicester, etc.	98
————— in Exeter	99
————— in Hull	100
————— in York	101
————— in Dumfries, etc.	102
————— in Nottingham and Glasgow	103
————— in Paris and Newcastle upon Tyne	104

	PAGE
Limited inquiry respecting the effect of the water supply at Newcastle	107
Assent of the medical profession to the influence of polluted water on the mortality from cholera	109
True explanation of this influence	110
Answers to certain objections	111
Circumstances connected with the history of cholera explained by the principles advocated in this treatise, as,—	
The duration of the epidemic in each place usually bears a direct relation to the number of the population	115
The effect of season on the prevalence of cholera .	117
Proportion of the sexes who die of cholera at different periods of an epidemic, and under different circum- stances	119
Proportion of deaths from cholera in certain occu- pations	121
Evidence that plague, yellow fever, dysentery, and typhoid fever are communicated in the same way as cholera .	125
Instances in which ague was caused by impure water .	129
Measures required for the prevention of cholera and other dis- eases which are communicated in the same way .	133
Appendix, containing a list of the deaths from cholera which were registered in the four weeks ending 5th August 1854, together with the water supply of the houses in which the fatal attacks took place, in all the sub-districts to which the supply of either the Southwark and Vaux- hall or the Lambeth Water Company extends . . .	138

MAPS.

Map 1. Showing the deaths from cholera in Broad Street, Golden Square, and the neighbourhood, from 19th August to 30th September 1854. A black mark or bar for each death is placed in the situation of the house in which the fatal attack took place. The situation of the Broad Street Pump is also indicated, as well as that of all the surrounding Pumps to which the public had access.

Map 2. Showing the boundaries of the Registrar-General's districts on the south side of the Thames in London, and also the water supply of those districts.

ON THE
MODE OF COMMUNICATION OF
CHOLERA.

THE existence of Asiatic Cholera cannot be distinctly traced back further than the year 1769. Previous to that time the greater part of India was unknown to European medical men ; and this is probably the reason why the history of cholera does not extend to a more remote period. It has been proved by various documents, quoted by Mr. Scot,* that cholera was prevalent at Madras in the year above mentioned, and that it carried off many thousands of persons in the peninsula of India from that time to 1790. From this period we have very little account of the disease till 1814, although, of course, it might exist in many parts of Asia without coming under the notice of Europeans.

In June 1814, the cholera appeared with great severity in the 1st bat. 9th regt. N. I., on its march from Jaulnah to Trichinopoly ; while another battalion, which accompanied it, did not suffer, although it had been exposed to exactly the same circumstances, with one exception. Mr. Cruikshanks, who attended the cases, made a report, which will be alluded to further on.

In 1817, the cholera prevailed with unusual virulence at several places in the Delta of the Ganges ; and, as it

* Report on the Epidemic Cholera, 1824, p. 5.

had not been previously seen by the medical men practising in that part of India, it was thought by them to be a new disease. At this time the cholera began to spread to an extent not before known ; and, in the course of seven years, it reached, eastward, to China and the Philippine Islands ; southward, to the Mauritius and Bourbon ; and to the north-west, as far as Persia and Turkey. Its approach towards our own country, after it entered Europe, was watched with more intense anxiety than its progress in other directions. It would occupy a long time to give an account of the progress of cholera over different parts of the world, with the devastation it has caused in some places, whilst it has passed lightly over others, or left them untouched ; and unless this account could be accompanied with a description of the physical condition of the places, and the habits of the people, which I am unable to give, it would be of little use.

There are certain circumstances, however, connected with the progress of cholera, which may be stated in a general way. It travels along the great tracks of human intercourse, never going faster than people travel, and generally much more slowly. In extending to a fresh island or continent, it always appears first at a sea-port. It never attacks the crews of ships going from a country free from cholera, to one where the disease is prevailing, till they have entered a port, or had intercourse with the shore. Its exact progress from town to town cannot always be traced ; but it has never appeared except where there has been ample opportunity for it to be conveyed by human intercourse.

There are also innumerable instances which prove the communication of cholera, by individual cases of the disease, in the most convincing manner. Instances such as the following seem free from every source of fallacy.

I called lately to inquire respecting the death of Mrs.

Gore, the wife of a labourer, from cholera, at New Leigham Road, Streatham. I found that a son of deceased had been living and working at Chelsea. He came home ill with a bowel complaint, of which he died in a day or two. His death took place on August 18th. His mother, who attended on him, was taken ill on the next day, and died the day following (August 20th). There were no other deaths from cholera registered in any of the metropolitan districts, down to the 26th August, within two or three miles of the above place; the nearest being at Brixton, Norwood, or Lower Tooting.

The first case of decided Asiatic cholera in London, in the autumn of 1848, was that of a seaman named John Harnold, who had newly arrived by the *Elbe* steamer from Hamburgh, where the disease was prevailing. He left the vessel, and went to live at No. 8, New Lane, Gainsford Street, Horsleydown. He was seized with cholera on the 22nd of September, and died in a few hours. Dr. Parkes, who made an inquiry into the early cases of cholera, on behalf of the then Board of Health, considered this as the first undoubted case of cholera.

Now the next case of cholera, in London, occurred in the very room in which the above patient died. A man named Blenkinsopp came to lodge in the same room. He was attacked with cholera on the 30th September, and was attended by Mr. Russell of Thornton Street, Horsleydown, who had attended John Harnold. Mr. Russell informed me that, in the case of Blenkinsopp, there were rice-water evacuations; and, amongst other decided symptoms of cholera, complete suppression of urine from Saturday till Tuesday morning; and after this the patient had consecutive fever. Mr. Russell had seen a great deal of cholera in 1832, and considered this a genuine case of the disease; and the history of it leaves no room for doubt.

The following instances are quoted from an interesting work by Dr. Simpson of York, entitled "Observations on Asiatic Cholera":—"The first cases in the series occurred at Moor Monkton, a healthy agricultural village, situated to the north-west of York, and distant six miles from that place. At the time when the first case occurred, the malady was not known to be prevailing anywhere in the neighbourhood, nor, indeed, at any place within a distance of thirty miles.

"John Barnes, aged 39, an agricultural labourer, became severely indisposed on the 28th of December 1832; he had been suffering from diarrhœa and cramps for two days previously. He was visited by Mr. George Hopps, a respectable surgeon at Redhouse, who, finding him sinking into collapse, requested an interview with his brother, Mr. J. Hopps, of York. This experienced practitioner at once recognized the case as one of Asiatic cholera; and, having bestowed considerable attention on the investigation of that disease, immediately enquired for some probable source of contagion, but in vain: no such source could be discovered. When he repeated his visit on the day following, the patient was dead; but Mrs. Barnes (the wife), Matthew Metcalfe, and Benjamin Muscroft, two persons who had visited Barnes on the preceding day, were all labouring under the disease, but recovered. John Foster, Ann Dunn, and widow Creyke, all of whom had communicated with the patients above named, were attacked by premonitory indisposition, which was however arrested. Whilst the surgeons were vainly endeavouring to discover whence the disease could possibly have arisen, the mystery was all at once, and most unexpectedly, unravelled by the arrival in the village of the son of the deceased John Barnes. This young man was apprentice to his uncle, a shoemaker, living at Leeds.

He informed the surgeons that his uncle's wife (his father's sister) had died of cholera a fortnight before that time, and that, as she had no children, her wearing apparel had been sent to Monkton by a common carrier. The clothes had not been washed ; Barnes had opened the box in the evening ; on the next day he had fallen sick of the disease.

“ During the illness of Mrs. Barnes, her mother, who was living at Tockwith, a healthy village five miles distant from Moor Monkton, was requested to attend her. She went to Monkton accordingly, remained with her daughter for two days, washed her daughter's linen, and set out on her return home, apparently in good health. Whilst in the act of walking home she was seized with the malady, and fell down in collapse on the road. She was conveyed home to her cottage, and placed by the side of her bedridden husband. He, and also the daughter who resided with them, took the malady. All the three died within two days. Only one other case occurred in the village of Tockwith, and it was not a fatal case.” (p. 136.)

“ A man came from Hull (where cholera was prevailing), by trade a painter ; his name and age are unknown. He lodged at the house of Samuel Wride, at Pocklington ; was attacked on his arrival on the 8th of September, and died on the 9th. Samuel Wride himself was attacked on the 11th of September, and died shortly afterwards. These comprise the first cases.

“ The next was that of a person named Kneeshaw, who had been at Wride's house. But as this forms one of a series connected with the former, furnished by Dr. Laycock, who has very obligingly taken the trouble to verify the dates and facts of the latter part of the series, it will be best to give the notes of these cases in that gentleman's own words.

“ ‘ My dear Dr. Simpson,—Mrs. Kneeshaw was attacked with cholera on Monday, September 9th, and her son William on the 10th. He died on Saturday the 15th; she lived three weeks; they lived at Pocklington. On Sunday, September 16th, Mr. and Mrs. Flint, and Mr. and Mrs. Giles Kneeshaw, and two children, went to Pocklington to see Mrs. Kneeshaw. Mrs. Flint was her daughter. They all returned the same day, except Mr. M. G. Kneeshaw, who stayed at Pocklington, until Monday, September 24th, when he returned to York. At three o’clock on the same day, he was attacked with cholera, and died Tuesday, September 25th, at three o’clock in the morning. [There had been no cholera in York for some time.] On Thursday, September 27th, Mrs. Flint was attacked, but recovered. On Saturday, September 29th, her sister, Mrs. Stead, came from Pocklington to York, to attend upon her; was attacked on Monday, October the 1st, and died October the 6th.

“ ‘ Mrs. Hardcastle, of No. 10, Lord Mayor’s Walk, York, was attacked with cholera on October 3rd, and died the same day. Miss Agar, residing with her, died of cholera on October 7th. Miss Robinson, who had come from Hull to take care of the house, after the death of Mrs. Hardcastle and Miss Agar, was attacked, and died on October 11th. Mr. C. Agar, of Stonegate, York, went to see Mrs. Hardcastle on October 3rd, was attacked next day, and died October 6th, early in the morning. On Monday, October 8th, Mrs. Agar, the mother of Mr. C. Agar, was attacked, and on the same day, one of the servants; both recovered. They had lived with Mr. Agar. All the above dates and facts I have verified.

“ ‘ I am, dear Dr. Simpson, yours very truly,

“ ‘ T. LAYCOCK.

“ ‘ Lendal, December 1st, 1849.’ ” (p. 160.)

Several other instances of the communication of cholera, quite as striking as the above, are related in Dr. Simpson's work.

The following account of the propagation of cholera has been published, along with several other histories of the same kind, in a pamphlet by Dr. Bryson.*

“ Mr. Greene, of Fraserburgh, gives the following account of the introduction of cholera into two villages in Scotland. Two boats, one belonging to Cairnbulgh and the other to Inveralochy, met at Montrose, and their crews on several occasions strolled through the town in company, although aware that it was at that time infected with cholera. On their passage homeward, they were obliged to put into Gourdon, where one man belonging to the Cairnbulgh boat died on the 22nd of September, after an illness of fourteen hours, with all the symptoms of cholera. Several of the men of both boats were at the same time attacked with serous diarrhœa, of which three of them had not recovered when they reached their respective homes ; nor indeed until the first cases of the epidemic broke out in the villages.

“ In Inveralochy the first case appeared on the 28th of September, three or four days after the arrival of the boat ; the sufferer, the father of one of the crew, had been engaged in removing the cargo along with other members of his family. Two other cases occurred in this family ; one on the 30th of September, and one on the 1st of October.

“ In Cairnbulgh, the first cases appeared on the 29th and 30th of September respectively, and both patients had also been engaged in removing the cargo of the boat (shell-fish) belonging to that village. No other cases appeared until the 3rd of October ; so that from the 28th

* On the Infectious Origin and Propagation of Cholera.

of September to the 3rd of October none were attacked in either village, but those who had come in contact with the suspected boats, or their crews.

“The subsequent cases were chiefly among relatives of those first attacked; and the order of their propagation was as follows. In Inveralochy, the first case was the father of a family; the second, his wife; the third, a daughter living with her parents; the fourth, a daughter who was married and lived in a different house, but who attended her father and mother during their illness; the fifth, the husband of the latter; and the sixth, his mother. Other cases occurred at the same time, although they were not known to have communicated with the former. One of them was the father of a family; the second his son, who was seized the day after his father, and a daughter the next day.”

The following instances of communication of cholera are taken from amongst many others in the “Report on Epidemic Cholera to the Royal College of Physicians”, by Dr. Baly.

“Stockport. (Dr. Rayner and Mr. J. Rayner, reporters). Sarah Dixon went to Liverpool, September 1st, to bury her sister, who had died of cholera there; returned to Stockport on September 3rd; was attacked with cholera on the 4th; was taken home by her mother to her mother’s house, a quarter of a mile distant; was in collapse, but recovered. Her mother was attacked on the 11th, and died. The brother, James Dixon, came from High Water to see his mother, and was attacked on the 14th.

“Liverpool. (Mr. Henry Taylor, reporter.) A nurse attended a patient in Great Howard Street (at the lower part of the town), and on her return home, near Everton (the higher part of the town), was seized, and died. The nurse who attended her was also seized, and died. No

other case had occurred previously in that neighbourhood, and none followed for about a fortnight.

“Hedon. (Dr. Sandwith, reporter.) Mrs. N. went from Paul, a village close to the Humber, to Hedon, two miles off, to nurse her brother in cholera ; the next day, after his death, went to nurse Mrs. B., also at Hedon ; within two days was attacked herself ; was removed to a lodging-house ; the son of the lodging-house keeper was attacked the next day, and died. Mrs. N.’s son removed her back to Paul ; was himself attacked two days afterwards, and died.”

It would be easy, by going through the medical journals and works which have been published on cholera, to quote as many cases similar to the above as would fill a large volume. But the above instances are quite sufficient to show that cholera can be communicated from the sick to the healthy ; for it is quite impossible that even a tenth part of these cases of consecutive illness could have followed each other by mere coincidence, without being connected as cause and effect.

Besides the facts above mentioned, which prove that cholera is communicated from person to person, there are others which show, first, that being present in the same room with a patient, and attending on him, do not necessarily expose a person to the morbid poison ; and, secondly, that it is not always requisite that a person should be very near a cholera patient in order to take the disease, as the morbid matter producing it may be transmitted to a distance. It used to be generally assumed, that if cholera were a catching or communicable disease, it must spread by effluvia given off from the patient into the surrounding air, and inhaled by others into the lungs. This assumption led to very conflicting opinions respecting the disease. A little reflection shews, however, that

we have no right thus to limit the way in which a disease may be propagated, for the communicable diseases of which we have a correct knowledge spread in very different manners. The itch, and certain other diseases of the skin, are propagated in one way ; syphilis, in another way ; and intestinal worms in a third way, quite distinct from either of the others.

A consideration of the pathology of cholera is capable of indicating to us the manner in which the disease is communicated. If it were ushered in by fever, or any other general constitutional disorder, then we should be furnished with no clue to the way in which the morbid poison enters the system ; whether, for instance, by the alimentary canal, by the lungs, or in some other manner, but should be left to determine this point by circumstances unconnected with the pathology of the disease. But from all that I have been able to learn of cholera, both from my own observations and the descriptions of others, I conclude that cholera invariably commences with the affection of the alimentary canal. The disease often proceeds with so little feeling of general illness, that the patient does not consider himself in danger, or even apply for advice, till the malady is far advanced. In a few cases, indeed, there are dizziness, faintness, and a feeling of sinking, before discharges from the stomach or bowels actually take place ; but there can be no doubt that these symptoms depend on the exudation from the mucous membrane, which is soon afterwards copiously evacuated. This is only what occurs in certain cases of hæmorrhage into the alimentary canal, where all the symptoms of loss of blood are present before that fluid shows itself in the evacuations. In those rare cases, called “ cholera sicca,” in which no purging takes place, the intestines have been found distended with the excretion peculiar to the dis-

ease, whenever an examination of the body has taken place after death. In all the cases of cholera that I have attended, the loss of fluid from the stomach and bowels has been sufficient to account for the collapse, when the previous condition of the patient was taken into account, together with the suddenness of the loss, and the circumstance that the process of absorption appears to be suspended.

The symptoms which follow the affection of the alimentary canal in cholera are exactly those which this affection is adequate, and, indeed, could not fail to produce. The analyses which have been made of the blood of cholera patients, show that the watery fluid effused into the stomach and bowels is not replaced by absorption, or is replaced only to a small extent. The analyses of Dr. O'Shaughnessy and others, during the cholera of 1831-32, show that the amount of water in the blood was very much diminished in proportion to the solid constituents, and that the salts of the blood were also diminished. The analyses of Dr. Garrod and Dr. Parkes, in the spring of 1849, were more numerous and exact.* The amount of water in the blood of healthy persons is on the average 785 parts in 1000; whereas, in the average of the analyses performed by Drs. Garrod and Parkes, it was only 733 parts, while the amount of solid constituents of the blood, relatively to the water, was increased from 215—the healthy standard—to 267. The globules, together with the albumen and other organic constituents of the serum, amount in the healthy state to 208 parts in 1000, while in the blood of cholera patients they amounted to 256 parts. The saline constituents in 1000 parts of blood are somewhat increased, on account of the great diminution of water; but, when estimated in relation to the other solid

* See "London Journal of Medicine," May, 1849.

ingredients, or to the whole quantity existing in the healthy body, the amount is diminished. Dr. Garrod is of opinion that a chemical analysis will determine whether or not a specimen of blood has been derived from a cholera patient.

The stools and vomited matters in cholera consist of water, containing a small quantity of the salts of the blood, and a very little albuminous substance. The change in the blood is precisely that which the loss by the alimentary canal ought to produce; and, indeed, it is physically impossible that the alteration in the blood can be caused in any other way. The sweating which takes place in an advanced stage of the disease may increase the density of the blood to a trifling extent; but it does not come on till the blood is already altered, and it is only a consequence of the diminished force of the circulation, like the sweating met with in collapse from hæmorrhage or severe injuries, and in faintness from venesection.

The loss of water from the blood causes it to assume the thick tarry appearance, so well known to all who have opened a vein in cholera.—The diminished volume of the blood causes many of the symptoms of a true hæmorrhage, as debility, faintness, and coldness; while these effects are much increased by its thick and tenacious condition, which impedes its passage through the pulmonary capillaries, thereby reducing the contents of the arteries throughout the system to the smallest possible amount, as indicated by the small thready pulse. The interruption to the pulmonary circulation occasioned by the want of fluidity of the blood, is the cause of the distressing feeling of want of breath. Proofs of the obstructed circulation through the lungs generally remain after death, in the distended state of the pulmonary arteries and right cavities of the heart. The deficient supply of blood to the various organs, and its unfitness to pass through the capillaries,

are the cause of the suppression of the renal, biliary, and other secretions. The cramps appear to consist chiefly of reflex action, caused by the irritation, and probably the distension, of the bowels.

If any further proof were wanting than those above stated, that all the symptoms attending cholera, except those connected with the alimentary canal, depend simply on the physical alteration of the blood, and not on any cholera poison circulating in the system, it would only be necessary to allude to the effects of a weak saline solution injected into the veins in the stage of collapse. The shrunken skin becomes filled out, and loses its coldness and lividity; the countenance assumes a natural aspect; the patient is able to sit up, and for a time seems well. If the symptoms were caused by a poison circulating in the blood, and depressing the action of the heart, it is impossible that they should thus be suspended by an injection of warm water, holding a little carbonate of soda in solution.

It has often been contended that the collapse of cholera cannot be the mere result of the purging and vomiting, because, in some of the most rapid and malignant cases, the amount of the stools and vomited fluid is less than in milder and more protracted ones, or even in some cases in which the patients recover. But, in the most rapid and malignant cases, there is sufficient loss of aqueous fluid by the alimentary canal to alter the blood into the thick tenacious state peculiar to this disease; and the fact of more purging occurring in other cases which are more protracted, only proves that, in these latter, absorption from the stomach and intestines has not been altogether arrested, or that the stools have been diluted with fluids drank by the patient. The loss of fluid in every case of fully developed cholera must be sufficient to cause the

thickened state of the blood, which is the cause of the algide symptoms ; and the amount of malignancy of the case must depend chiefly on the extent to which the function of absorption is impaired.

If absorption were altogether arrested in every case of cholera from the beginning, the amount of discharge from the alimentary canal would not equal that of a fatal hæmorrhage, for the thickened blood which remains is certainly not able to maintain life so well as the same quantity of healthy blood. Indeed, it is easy to calculate the amount of fluid separated from the blood, by means of the analyses previously quoted, and others which have been made of the cholera stools. In some analyses of these evacuations made by Dr. Parkes,* the average composition in 1,000 parts was found to be 982.4 water and 17.6 solids ; consequently, the problem is merely to find how much of such a fluid requires to be subtracted from blood consisting of water 785 and solids 215, in 1000 parts, in order to reduce it to blood consisting of water 733 and solids 267. The answer to this problem is that 208.5 parts would require to be subtracted from 1000 parts of blood. M. Valentin has estimated the average amount of blood in the human adult at thirty pounds ; and, therefore, the whole quantity of fluid that requires to be effused into the stomach and bowels, in order to reduce the blood of a healthy adult individual to the condition in which it is met with in the collapse of cholera is, on the average, 100 ounces, or five imperial pints. This calculation may be useful as indicating the amount of fluid which ought not to be exceeded in the injection of the blood vessels.

Diseases which are communicated from person to person are caused by some material which passes from the sick to

* London Journal of Medicine, loc. cit.

the healthy, and which has the property of increasing and multiplying in the systems of the persons it attacks. In syphilis, small-pox, and vaccinia, we have physical proof of the increase of the morbid material, and in other communicable diseases the evidence of this increase, derived from the fact of their extension, is equally conclusive. As cholera commences with an affection of the alimentary canal, and as we have seen that the blood is not under the influence of any poison in the early stages of this disease,* it follows that the morbid material producing cholera must be introduced into the alimentary canal—must, in fact, be swallowed accidentally, for persons would not take it intentionally; and the increase of the morbid material, or cholera poison, must take place in the interior of the stomach and bowels. It would seem that the cholera poison, when reproduced in sufficient quantity, acts as an irritant on the surface of the stomach and intestines, or, what is still more probable, it withdraws fluid from the blood circulating in the capillaries, by a power analogous to that by which the epithelial cells of the various organs abstract the different secretions in the healthy body. For the morbid matter of cholera having the property of reproducing its own kind, must necessarily have some sort of structure, most likely that of a cell: It is no objection to this view that the structure of the cholera poison cannot be recognised by the microscope, for the matter of small-pox and of chancre can only be recognised by their effects, and not by their physical properties.

The period which intervenes between the time when a morbid poison enters the system, and the commencement of the illness which follows, is called the period of incubation. It is, in reality, a period of reproduction, as regards

* In the so-called secondary fever there is toxicohæmia, arising from suppressed excretion by the kidneys.

the morbid matter ; and the disease is due to the crop or progeny resulting from the small quantity of poison first introduced. In cholera, this period of incubation or reproduction is much shorter than in most other epidemic or communicable diseases. From the cases previously detailed, it is shown to be in general only from twenty-four to forty-eight hours. It is owing to this shortness of the period of incubation, and to the quantity of the morbid poison thrown off in the evacuations, that cholera sometimes spreads with a rapidity unknown in other diseases.

The mode of communication of cholera might have been the same as it is, even if it had been a disease of the blood ; for there is a good deal of evidence to show that plague, typhoid fever, and yellow fever, diseases in which the blood is affected, are propagated in the same way as cholera. There is sufficient evidence also, I believe, in the following pages, to prove the mode of communication of cholera here explained, independently of the pathology of the disease ; but it was from considerations of its pathology that the mode of communication was first explained, and, if the views here propounded are correct, we had a knowledge of cholera, before it had been twenty years in Europe, more correct than that of most of the older epidemics ; a knowledge which, indeed, promises to throw much light on the mode of propagation of many diseases which have been present here for centuries.

The instances in which minute quantities of the ejections and dejections of cholera patients must be swallowed are sufficiently numerous to account for the spread of the disease ; and on examination it is found to spread most where the facilities for this mode of communication are greatest. Nothing has been found to favour the extension of cholera more than want of personal cleanliness, whether arising from habit or scarcity of water, although the

circumstance till lately remained unexplained. The bed linen nearly always becomes wetted by the cholera evacuations, and as these are devoid of the usual colour and odour, the hands of persons waiting on the patient become soiled without their knowing it ; and unless these persons are scrupulously cleanly in their habits, and wash their hands before taking food, they must accidentally swallow some of the excretion, and leave some on the food they handle or prepare, which has to be eaten by the rest of the family, who, amongst the working classes, often have to take their meals in the sick room : hence the thousands of instances in which, amongst this class of the population, a case of cholera in one member of the family is followed by other cases ; whilst medical men and others, who merely visit the patients, generally escape. The *post mortem* inspection of the bodies of cholera patients has hardly ever been followed by the disease that I am aware, this being a duty that is necessarily followed by careful washing of the hands ; and it is not the habit of medical men to be taking food on such an occasion. On the other hand, the duties performed about the body, such as laying it out, when done by women of the working class, who make the occasion one of eating and drinking, are often followed by an attack of cholera ; and persons who merely attend the funeral, and have no connexion with the body, frequently contract the disease, in consequence, apparently, of partaking of food which has been prepared or handled by those having duties about the cholera patient, or his linen and bedding.

Deficiency of light is a great obstacle to cleanliness, as it prevents dirt from being seen, and it must aid very much the contamination of the food with the cholera evacuations. Now the want of light, in some of the dwellings of the poor, in large towns, is one of the cir-

cumstances that has often been commented on as increasing the prevalence of cholera.

The involuntary passage of the evacuations in most bad cases of cholera, must also aid in spreading the disease. Mr. Baker, of Staines, who attended two hundred and sixty cases of cholera and diarrhœa in 1849, chiefly among the poor, informed me, in a letter with which he favoured me in December of that year, that "when the patients passed their stools involuntarily the disease evidently spread." It is amongst the poor, where a whole family live, sleep, cook, eat, and wash in a single room, that cholera has been found to spread when once introduced, and still more in those places termed common lodging-houses, in which several families were crowded into a single room. It was amongst the vagrant class, who lived in this crowded state, that cholera was most fatal in 1832; but the Act of Parliament for the regulation of common lodging-houses, has caused the disease to be much less fatal amongst these people in the late epidemics. When, on the other hand, cholera is introduced into the better kind of houses, as it often is, by means that will be afterwards pointed out, it hardly ever spreads from one member of the family to another. The constant use of the hand-basin and towel, and the fact of the apartments for cooking and eating being distinct from the sick room, are the cause of this.

The great prevalence of cholera in institutions for pauper children and pauper lunatics, whenever it has gained access to these buildings, meets with a satisfactory explanation according to the principles here laid down. In the asylum for pauper children at Tooting, one hundred and forty deaths from cholera occurred amongst a thousand inmates, and the disease did not cease till the remaining children had been removed. The children were

placed two or three in a bed, and vomited over each other when they had the cholera. Under these circumstances, and when it is remembered that children get their hands into everything, and are constantly putting their fingers in their mouths, it is not surprising that the malady spread in this manner, although I believe as much attention was paid to cleanliness as is possible in a building crowded with children. Pauper lunatics are generally a good deal crowded together, especially in their sleeping wards, and as the greater number of them are in a state of imbecility, they are no more careful than children in the use of their hands. It is with the greatest difficulty that they can be kept even moderately clean. As might be expected, according to the views here explained, the lunatic patients generally suffered in a much greater proportion than the keepers and other attendants.

The mining population of Great Britain have suffered more from cholera than persons in any other occupation,—a circumstance which I believe can only be explained by the mode of communication of the malady above pointed out. Pitmen are differently situated from every other class of workmen in many important particulars. There are no privies in the coal-pits, or, as I believe, in other mines. The workmen stay so long in the mines that they are obliged to take a supply of food with them, which they eat invariably with unwashed hands, and without knife and fork. The following is a reply which I received from a relative of mine connected with a colliery near Leeds, in answer to an inquiry I made :—

“ Our colliers descend at five o'clock in the morning, to be ready for work at six, and leave the pit from one to half-past three. The average time spent in the pit is eight to nine hours. The pitmen all take down with them a supply of food, which consists of cake, with the addition,

in some cases, of meat ; and all have a bottle, containing about a quart of ‘drink’. I fear that our colliers are no better than others as regards cleanliness. The pit is one huge privy, and of course the men always take their victuals with unwashed hands.”

It is very evident that, when a pitman is attacked with cholera whilst at work, the disease has facilities for spreading among his fellow-labourers such as occur in no other occupation. That the men are occasionally attacked whilst at work I know, from having seen them brought up from some of the coal-pits in Northumberland, in the winter of 1831-2, after having had profuse discharges from the stomach and bowels, and when fast approaching to a state of collapse.

Dr. Baly, who has done me the honour of giving a very full and impartial account of my views in his “ Report on Cholera to the College of Physicians”, makes the objection to what I have said about the colliers, that the women and children who do not work in the mines, were attacked in as large numbers as the men. I believe, however, that this is only what ought to occur from the propagation of the cholera in the crowded dwellings of the pitmen, in the manner previously explained. The only effect of its communication in the pits would be, that the men and boys in a family would have the cholera a day or two earlier than the women and children ; and if a special inquiry were made on this point, this would probably be found to be the case. It has often been said that, if cholera were a communicable disease, women ought to suffer in much greater numbers than the men, as they are employed in nursing the sick. I leave this objection and Dr. Baly’s to combat each other.

It is very probable that, when cholera occurs amongst people who are employed in the preparation or vending

of provisions, the disease may be spread by this means, although from the nature of the subject it is hardly to be expected that the fact would be discovered. The following cases, perhaps, afford as decisive proof of this variety of communication of cholera as can be expected. In the beginning of 1850, a letter appeared in the *Provincial Medical and Surgical Journal*, from Mr. John C. Bloxam, in the Isle of Wight, being an answer to the inquiry on cholera by Mr. Hunt. Among other interesting information, Mr. Bloxam stated, that the only cases of cholera that occurred in the village of Carisbrook, happened in persons who ate of some stale cow-heels, which had been the property of a man who died in Newport, after a short and violent attack of cholera. Mr. Bloxam kindly made additional personal inquiries into the case, in consequence of questions I put to him, and the following is a summary of the information contained in his letter :—

The man from whose house the cow-heels were sent for sale died on Monday, the 20th of August. It was the custom in the house to boil these articles on Monday, Wednesday, and Friday ; and the cow-heels under consideration were taken to Carisbrook, which is a mile from Newport, ready boiled, on Tuesday the 21st. Eleven persons in all partook of this food, seven of whom ate it without any additional cooking. Six of these were taken ill within twenty-four hours after eating it, five of whom died, and one recovered. The seventh individual, a child, who ate but a small quantity of the cow-heels, was unaffected by it. Four persons partook of the food after additional cooking. In one case the cow-heels were fried, and the person who ate them was taken ill of cholera within twenty-four hours afterwards, and died. Some of the food was made into broth, of which three persons partook while it was warm; two of them remained well, but the third

person partook again of the broth next day, when cold, and, within twenty-four hours after this latter meal, she was taken ill with cholera, of which she died. It may be proper to mention, although it is no unusual circumstance for animal food to be eaten in hot weather when not quite fresh, that some of the persons perceived the cow-heels to be not so fresh as they ought to have been at the time they were eaten, and part of them had to be thrown away a day or two afterwards, in consequence of being quite putrid.

It is not unlikely that some of the cases of cholera which spring up without any apparent connection with previous cases, may be communicated through articles of diet. It is the practice of the poor people, who gain a living by selling fruit and other articles in the streets, to keep their stock in very crowded rooms in which they live, and, when visiting the out-patients of a medical charity a few years ago, I often saw baskets of fruit pushed under the beds of sick patients, in close proximity with the chamber utensils. I need hardly say that if cases of disease were propagated in this way, it would be quite impossible to trace them.

If the cholera had no other means of communication than those which we have been considering, it would be constrained to confine itself chiefly to the crowded dwellings of the poor, and would be continually liable to die out accidentally in a place, for want of the opportunity to reach fresh victims; but there is often a way open for it to extend itself more widely, and to reach the well-to-do classes of the community; I allude to the mixture of the cholera evacuations with the water used for drinking and

culinary purposes, either by permeating the ground, and getting into wells, or by running along channels and sewers into the rivers from which entire towns are sometimes supplied with water.

In 1849 there were in Thomas Street, Horsleydown, two courts close together, consisting of a number of small houses or cottages, inhabited by poor people. The houses occupied one side of each court or alley—the south side of Trusscott's Court, and the north side of the other, which was called Surrey Buildings, being placed back to back, with an intervening space, divided into small back areas, in which were situated the privies of both the courts, communicating with the same drain, and there was an open sewer which passed the further end of both courts. Now, in Surrey Buildings the cholera committed fearful devastation, whilst in the adjoining court there was but one fatal case, and another case that ended in recovery. In the former court, the slops of dirty water, poured down by the inhabitants into a channel in front of the houses, got into the well from which they obtained their water; this being the only difference that Mr. Grant, the Assistant-Surveyor for the Commissioners of Sewers, could find between the circumstances of the two courts, as he stated in a report that he made to the Commissioners. The well in question was supplied from the pipes of the Southwark and Vauxhall Waterworks, and was covered in on a level with the adjoining ground; and the inhabitants obtained the water by a pump placed over the well. The channel mentioned above commenced close by the pump. Owing to something being out of order, the water had for some time occasionally burst out at the top of the well, and overflowed into the gutter or channel, afterwards flowing back again mixed with the impurities; and crevices were left in the ground or pavement, allow-

ing part of the contents of the gutter to flow at all times into the well ; and when it was afterwards emptied, a large quantity of black and highly offensive deposit was found.

The first case of cholera in this court occurred on July 20th, in a little girl, who had been labouring under diarrhœa for four days. This case ended favourably. On the 21st July, the next day, an elderly female was attacked with the disease, and was in a state of collapse at ten o'clock the same night. This patient partially recovered, but died of some consecutive affection on August 1. Mr. Vinen, of Tooley Street, who attended these cases, states that the evacuations were passed into the beds, and that the water in which the foul linen was washed would inevitably be emptied into the channel mentioned above. Mr. Russell, of Thornton Street, Horsleydown, who attended many of the subsequent cases in the court, and who, along with another medical gentleman, was the first to call the attention of the authorities to the state of the well, says that such water was invariably emptied there, and the people admit the circumstance. About a week after the above two cases commenced, a number of patients were taken ill nearly together : four on Saturday, July 28th, seven or eight on the 29th, and several on the day following. The deaths in the cases that were fatal took place as follows :—one on the 29th, four on the 30th, and one on the 31st July ; two on August 1st, and one on August the 2nd, 5th, and 10th respectively, making eleven in all. They occurred in seven out of the fourteen small houses situated in the court.

The two first cases on the 20th and 21st were probably caused by the cholera evacuations contained in the Thames water, as it came from the waterworks, and they may be considered to represent about the average amount of cases for the neighbourhood, there having been just that number

in the adjoining court, about the same time. But in a few days, when the dejections of these patients must have become mixed with the water the people drank, a number of additional cases commenced nearly together. The patients were all women and children, the men living in the court not having been attacked ; they may have been out at work all day and not have drank the water, but as the surviving inhabitants nearly all left the place immediately after the above mortality occurred, I was not able to ascertain whether this was so or not.

In Albion Terrace, Wandsworth Road, there was an extraordinary mortality from cholera in 1849, which was the more striking as there were no other cases at the time in the immediate neighbourhood ; the houses opposite to, behind, and in the same line, at each end of those in which the disease prevailed, having been free from it. The row of houses in which the cholera prevailed to an extent probably at that time quite unprecedented in this country, constituted the genteel suburban dwellings of a number of professional and tradespeople, and are most of them detached a few feet from each other. They were supplied with water on the same plan. In this instance the water got contaminated by the contents of the house drains and cesspools. The cholera extended to nearly all the houses in which the water was thus tainted, and to no others.

These houses were numbered from 1 to 17, in Albion Terrace, and were supplied with water from a copious spring in the road in front of the terrace, the water of which was conducted, by a brick barrel-drain between Nos. 7 and 8, to the back of the houses, and then flowed right and left, to supply tanks in the ground behind each house, the tanks being made of brickwork and cement, covered with a flat stone, and connected with each other by stoneware pipes six inches in diameter. A leaden pipe

conveyed water from each tank to a pump situated in the back kitchen. There was a cesspool behind each house, under the privy, and situated four feet from the water tank. The ground was opened behind the houses No. 1 and No. 7, and the drains examined under the superintendence of Mr. Grant, the Assistant-Surveyor to the Commissioners of Sewers. The cesspools at both these places were quite full, and the overflow-drain from that at No. 1 choked up. At this house the respective levels of the cesspool and the water-tank were measured, and the top of the overflow-drain from the cesspool was found to be fifteen inches above the top of the tank, and the intervening ground was very wet. The overflow-drain mentioned above had no bottom, or one so soft that it could be penetrated with a stick ; and it crossed, at right angles, above the earthenware pipe of the water-tank, the joints of which were leaky, and allowed the water to escape. Behind No. 7, Mr. Grant found a pipe for bringing surplus water from the tanks, communicating with a drain from the cesspool ; and he found a flat brick drain laid over the barrel-drain before mentioned, which brought the water from the spring. It appears, from a plan of the property, that this drain, which was continued in a direction towards the sewer in Battersea Fields, brought surface-drainage from the road, and received the drains from the cesspools, the house-drains from the sinks in the back kitchens, and the surplus water, or some of it, from the tanks. There was every reason to believe that this drain was stopped up, but that was not ascertained : at all events it was unable to convey the water flowing into it during the storm on July 26th, as it burst near the house No. 8, and inundated the lower premises of that and the adjoining house, No. 9, with foetid water ; and it was from this time that the water, which had occasionally been complained of before, was

found by most of the people in these seventeen houses to be more or less impure or disagreeable. The water broke out of the drain again at No. 8, and overflowed the kitchens, during a heavy rain on August 2nd. It should be particularly remarked, that the tanks were placed on the same level, so that pumping from one would draw water from the others, and that any impurity getting into one tank would consequently be imparted to the rest.

The first case of cholera occurred at No. 13, on July 28th (two days after the bursting of the drain), in a lady who had had premonitory symptoms for three or four days. It was fatal in fourteen hours. There was an accumulation of rubbish in the cellar of this house, which was said to be offensive by the person who removed it; but the proprietor of the house denied this. A lady at No. 8 was attacked with choleraic diarrhœa on July 30th: she recovered. On August 1st, a lady, aged eighty-one, at No. 6, who had had some diarrhœa eight or ten days before, which had yielded to her own treatment, was attacked with cholera: she died on the 4th with congested brain. Diarrhœa commenced on August 1st in a lady aged 60, at No. 3; collapse took place on the 5th, and death on the 6th. On August 3rd, there were three or four cases, in different parts of the row of houses, and two of them terminated fatally on the same day. The attacks were numerous during the following three or four days, and after that time they diminished in number. More than half the inhabitants of the part of the terrace in which the cholera prevailed, were attacked with it, and upwards of half the cases were fatal. The deaths occurred as follows; but as some of the patients lingered a few days, and died in the consecutive fever, the deaths are less closely grouped than the seizures. There was one death on July 28th, two on August 3rd, four on the 4th, two on the 6th,

two on the 7th, four on the 8th, three on the 9th, one on the 11th, and one on the 13th. These make twenty fatal cases ; and there were four or five deaths besides amongst those who were attacked after flying from the place.

The fatal cases were distributed over ten out of the seventeen houses ; and Mr. Mimpriss of Wandsworth Road, who attended many of the cases, and to whose kindness I am indebted for several of these particulars, stated that cases occurred in the other seven houses, with the exception of one or two that were empty, or nearly so. There were five deaths in the house No. 6 ; and one of a gentleman the day after he left it, and went to Hampstead Heath. The entire household, consisting of seven individuals, had the cholera, and six of them died.

There are no data for showing how the disease was communicated to the first patient, at No. 13, on July 28th ; but it was two or three days afterwards, when the evacuations from this patient must have entered the drains having a communication with the water supplied to all the houses, that other persons were attacked, and in two days more the disease prevailed to an alarming extent.

I had an opportunity of examining some of the water removed by Mr. Grant from the tanks behind the houses No. 1 and No. 7, and also some of the deposit which lay in the tanks to the depth of from six to nine inches. The water was offensive, and the deposit possessed the odour of privy soil very distinctly, I found in it various substances which had passed through the alimentary canal, having escaped digestion, as the stones and husks of currants and grapes, and portions of the thin epidermis of other fruits and vegetables.

Many of the patients attributed their illness to the water. This is here mentioned to show that they had drank of it, and at the same time found that it was impure. As

explaining how persons might drink of such water before finding out its impurity, it may be stated that the grosser part of the material from drains and cesspools has a tendency, when mixed with water, to settle rapidly to the bottom. The only houses supplied with the same water, after passing the tanks in Albion Terrace, were four in Albion Street ; but three of these had been empty for months, and the fourth was inhabited by a gentleman who always suspected the water, and would not drink it. There were two or three persons attacked with cholera amongst those who came to nurse the patients after the water was condemned, and who, consequently, did not drink it ; but these persons were liable, in waiting on the patient, to get a small portion of the evacuations into the stomach in the way first pointed out ; and there might be food in the houses, previously prepared with the tainted water. It is not here implied that every one of the cases in Albion Terrace was communicated by the water, but that far the greater portion of them were ; that, in short, it was the circumstance of the cholera evacuations getting into the water, which caused the disease to spread so much beyond its ordinary extent.

The mortality in Albion Terrace was attributed by Dr. Milroy, in a published report to the General Board of Health, chiefly to three causes : first, to an open sewer in Battersea Fields, which is four hundred feet to the north of the terrace, and from which the inhabitants perceived a disagreeable odour when the wind was in certain directions ; secondly, to a disagreeable odour from the sinks in the back kitchens of the houses, which was worse after the storm of July 26 ; and lastly, to the accumulation in the house No. 13, before alluded to. With respect to the open sewer, there are several streets and lines of houses as much exposed to any emanations there might be from

it, as those in which the cholera prevailed ; and yet they were quite free from the malady, as were also nineteen houses situated between the sewer and Albion Terrace. As regards the bad smells from the sinks in the kitchen, their existence is of such every-day and almost universal prevalence, that they do not help to explain an irruption of cholera like that under consideration ; indeed, offensive odours were created in thousands of houses in London by the same storm of rain on July 26th ; and the two houses in which the offensive smell was greatest, viz. Nos. 8 and 9—those which were flooded with the contents of the drain—were less severely visited with cholera than the rest ; the inhabitants having only had diarrhœa, or mild attacks of cholera. The accumulation in the house No. 13 could not affect the houses at a distance from it. It remains evident then, that the only special and peculiar cause connected with the great calamity which befel the inhabitants of these houses, was the state of the water, which was followed by the cholera in almost every house to which it extended, whilst all the surrounding houses were quite free from the disease. Indeed, the General Board of Health attributed the mortality at this place to the contamination of the water, in a manifesto which they published not long after Dr. Milroy's report.*

Dr. Lloyd mentioned some instances of the effects of impure water at the South London Medical Society, on August 30th, 1849.† In Silver Street, Rotherhithe, there were eighty cases, and thirty-eight deaths, in the course of a fortnight early in July of that year, at a time when there was very little cholera in any other part of Rotherhithe. The contents of all the privies in this street ran into a drain which had once had a communication with the

* See "London Gazette", 18th Sept. 1849.

† See Report in "Med. Gaz.", vol. ii, 1849, p. 429.

Thames ; and the people got their supply of water from a well situated very near the end of the drain, with the contents of which the water got contaminated. Dr. Lloyd informed me that the fetid water from the drain could be seen dribbling through the side of the well, above the surface of the water. Amongst other sanitary measures recommended by Dr. Lloyd was the filling up of the well ; and the cholera ceased in Silver Street as soon as the people gave over using the water. Another instance alluded to by Dr. Lloyd, was Charlotte Place, in Rotherhithe, consisting of seven houses, the inhabitants of which, excepting those of one house, obtained their water from a ditch communicating with the Thames, and receiving the contents of the privies of all the seven houses. In these houses there were twenty-five cases of cholera, and fourteen deaths ; one of the houses had a pump railed off, to which the inhabitants of the other houses had no access, and there was but one case in that house.

The following instance, as well as some others of a similar kind, is related in the “ Report of the General Board of Health on the Cholera of 1848 and 1849.”

“ In Manchester, a sudden and violent outbreak of cholera occurred in Hope Street, Salford. The inhabitants used water from a particular pump-well. This well had been repaired, and a sewer which passes within nine inches of the edge of it became accidentally stopped up, and leaked into the well. The inhabitants of thirty houses used the water from this well ; among them there occurred nineteen cases of diarrhœa, twenty-six cases of cholera, and twenty-five deaths. The inhabitants of sixty houses in the same immediate neighbourhood used other water ; among these there occurred eleven cases of diarrhœa, but not a single case of cholera, nor one death. It is remarkable, that, in this instance, out of the twenty-six persons

attacked with cholera, the whole perished except one.”—
Page 62.

Dr. Thomas King Chambers informed me, that at Ilford, in Essex, in the summer of 1849, the cholera prevailed very severely in a row of houses a little way from the main part of the town. It had visited every house in the row but one. The refuse which overflowed from the privies and a pigsty could be seen running into the well over the surface of the ground, and the water was very fetid; yet it was used by the people in all the houses except that which had escaped cholera. That house was inhabited by a woman who took linen to wash, and she, finding that the water gave the linen an offensive smell, paid a person to fetch water for her from the pump in the town, and this water she used for culinary purposes, as well as for washing.

The following circumstance was related to me, at the time it occurred, by a gentleman well acquainted with all the particulars. The drainage from the cesspools found its way into the well attached to some houses at Locksbrook, near Bath, and the cholera making its appearance there in the autumn of 1849, became very fatal. The people complained of the water to the gentleman belonging to the property, who lived at Weston, in Bath, and he sent a surveyor, who reported that nothing was the matter. The tenants still complaining, the owner went himself, and on looking at the water and smelling it, he said that he could perceive nothing the matter with it. He was asked if he would taste it, and he drank a glass of it. This occurred on a Wednesday; he went home, was taken ill with the cholera, and died on the Saturday following, there being no cholera in his own neighbourhood at the time.

There is no spot in this country in which the cholera

was more fatal during the epidemic of 1832 than the village of Newburn, near Newcastle-upon-Tyne. We are informed, in an excellent paper on the subject by Dr. David Craigie,* that exactly one-tenth of the population died. The number of the inhabitants was five hundred and fifty; of these, three hundred and twenty suffered from the epidemic, either in the form of diarrhœa or the more confirmed disease, and the deaths amounted to fifty-five. Being aware of this mortality, I wrote, about the beginning of the year 1849, to a friend in Newcastle—Dr. Embleton—to make inquiries respecting the water used at Newburn, and he kindly procured me some information from the Rev. John Reed, of Newburn Vicarage, which I received in February, as well as an answer from Mr. Davison, surgeon, of Newburn, to whom I had written in the meantime. I learnt from these communications that the people were supplied with water in 1832, as they still were, from three wells, two of which were very little used, and that the water in the third well was derived from the workings of an old coal-mine near the village. The water of this well, as I was informed, although generally good when first drawn, became putrid after being kept two days. It was considered that the evacuations of the people could not get into any of the wells; but the vicar thought that the water of a little brook which runs past the village, and falls into the Tyne immediately afterwards, might find its way into that well which is chiefly resorted to. Putrefaction, on being kept a day or two, is so much the character of water containing animal matter, that, after receiving confirmation of my views respecting the communication of cholera by water from many other places, I wrote to Mr. Davison again on the subject, and he kindly took a great deal of trouble to

* Edin. Med. and Sur. Jour., vol. xxxvii.

investigate the matter further. He informed me that the brook was principally formed by water which was constantly pumped from coal-pits in the neighbourhood. About half a mile before reaching Newburn it received the refuse of a small village, and between that village and Newburn it ran through a privy used by the workmen of a steel factory. In Newburn this brook received the contents of the open drains or gutters from the houses. The drain which conveyed water from a coal mine or drift not worked for a great number of years, to the well mentioned above, passed underneath the brook at one part of its course, and from that point ran alongside of the brook to the well,—a distance of about three hundred yards. Mr. Davison said that it was disputed whether there was any communication between the drain and the brook, but that it was highly probable that there might be ; and that an occurrence which took place a few months previously seemed to prove that there was. Some gas-water from the steel manufactory mentioned above got by accident into the brook, and some of the people affirmed that the water in the well was strongly impregnated with it.

The first case of cholera in Newburn was that of a young man living close to the brook, about a hundred yards above the place at which it passes the well. He was taken ill on the 29th December, 1831, and died, in the stage of consecutive fever, on January 4th, 1832. There were some cases of diarrhœa in the village, but no new cases of cholera till the night of January the 9th, during which night and the following morning thirteen persons were taken ill. During the night of the 12th four persons were attacked ; by the 15th there were fourteen new cases, and on this day the late vicar died—the Rev. John Edmonston. By the next day at noon there were at least fifty new cases. A few days after this the

disease began to subside, and by the 2nd of February had almost disappeared. As several days elapsed between the first case of cholera and the great outbreak, it is probable that the water in which the soiled linen must have been washed, and which would necessarily run into the brook, was the means of communicating the disease to the thirteen persons taken ill on the night between the 9th and 10th of January ; unless, indeed, the intermediate cases of diarrhœa could transmit the disease.

The following passage is from the report of Mr. Cruikshanks on the outbreak of cholera in 1814, previously alluded to as occurring in a battalion on its march from Jaulnah to Trichinopoly.

“ It was the belief of the natives, strenuously fostered and inculcated by their spiritual guides, that the epidemic was the immediate consequence of the wrath of Heaven, outraged and insulted by the pollution of certain sacred tanks, situated at the village of Cunnatore, in which sepoy of low caste and camp followers had indiscriminately bathed. Such we may not regard as affording a very satisfactory solution of the difficulty ; yet it leads, I think, directly to the true point of inquiry. At Cunnatore, the force was so encamped, that while the 5th Native Infantry on the right had their supplies of water from wells, the puckallies of the 9th Native Infantry procured water for that battalion from tanks situated on low ground on the left of the line. The fact, that the disease first broke forth in a day or two after passing Cunnatore ; the prevailing opinion of the natives, that it originated there, and that somehow it was connected with the tanks ; a desire to discover some one cause confined in its influence and operation to one out of the two battalions ; lastly, the difficulty or impossibility of lighting on any other ; all these led to inquiry, and to ascertaining with a consider-

able degree of certainty, that each battalion was supplied with water from a source distinct from the other.”* The cholera was said not to be at Cunnatore at the time the infantry were encamped there, but this was probably a mistake.

The following quotation is from a letter by a medical officer in the Black Sea fleet, dated Baljik, August 23, 1854, and published in the *Medical Times and Gazette* of September 30th.

“A week after the return of the fleet to Baljik, on the 7th of August, about four thousand French troops encamped on the heights abreast our anchorage. These were part of the first division of the army that had marched to Kostenje, about ten days before. By it the first blood had been drawn on the part of the allied army. The loss in battle was small, but they had encountered an enemy more terrible than the Russians. The cholera had broken out among them, and attacking four hundred on the first night had destroyed sixty. The total loss had been something incredible. It was said, that out of eleven thousand men, not less than five thousand had perished in a few days. This dreadful calamity was attributed to drinking water from wells that had been poisoned by throwing in putrid carcases.

“Putting aside the question of intentional poisoning, which always presents itself as the most ready way of accounting for such destruction, perhaps some support to the theory, that water is the medium by which cholera poison is conveyed, may be found in this circumstance, and in another of which I was witness. These soldiers, wearied by marching from a focus of cholera infection, were seen, many of them, washing their persons and clothing in the stream from which all the French ships of

* Scot, “Report on the Epidemic Cholera”, p. 237.

war, and the majority of the English fleet, obtained their supply of water. This was going on on the 7th and 8th, and, on the nights of the 9th and 10th, the disease burst out with great violence among the crews of several ships.

“Some English ships were the first to suffer, on the night of the 9th, and they proceeded to sea next morning. On the night of the 10th, other English ships, and some of the French, began to suffer; and the latter in an almost unparalleled manner.

“The two admirals’ ships, *Montebello* and *Ville de Paris*, were terribly affected. On the previous day they had been in as healthy a state as usual; and in the night the cholera attacked, in the former, two hundred men, of whom forty lay dead in the morning; and in the *Ville de Paris* there were also many deaths. The French fleet sailed on the afternoon of the 11th; and the following morning saw the English ships also at sea.

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“On this day (the 14th), about noon, the *Britannia*, which had left port in a favourable condition, was attacked suddenly, and in twenty hours upwards of fifty of her crew had expired. We knew nothing of the calamity that had overwhelmed our leader until the following morning, when ‘reports of the sick’ were sent from each ship to the admiral. By this time (the evening of the 16th), eighty had died, and more than two hundred remained in greater or less danger.

“The night of the 16th must have been one of great consternation on board her. The epidemic went on with unchecked violence; the officers were voluntarily attending on the sick; and the very few of the crew who had not been attacked, or who were not assisting their unfortunate messmates, were found quite insufficient to perform the duties of a ship when under sail; and the admiral,

therefore, determined to return to Baljik, taking with him the *Trafalgar* and *Albion*, also badly affected.

“The crew of the *Britannia* were at once sent away from the ship, in small parties, into the numerous transports that remained idle ; and it appears that, by this procedure, the epidemic influences operating among them have been greatly moderated, if not extirpated.”

The most terrible outbreak of cholera which ever occurred in this kingdom, is probably that which took place in Broad Street, Golden Square, and the adjoining streets, a few weeks ago. Within two hundred and fifty yards of the spot where Cambridge Street joins Broad Street, there were upwards of five hundred fatal attacks of cholera in ten days. The mortality in this limited area probably equals any that was ever caused in this country, even by the plague ; and it was much more sudden, as the greater number of cases terminated in a few hours. The mortality would undoubtedly have been much greater had it not been for the flight of the population. Persons in furnished lodgings left first, then other lodgers went away, leaving their furniture to be sent for when they could meet with a place to put it in. Many houses were closed altogether, owing to the death of the proprietors ; and, in a great number of instances, the tradesmen who remained had sent away their families : so that in less than six days from the commencement of the outbreak, the most afflicted streets were deserted by more than three-quarters of their inhabitants.

There were a few cases of cholera in the neighbourhood of Broad Street, Golden Square, in the latter part of August ; and the so-called outbreak, which commenced in the night between the 31st August and the 1st September, was, as in all similar instances, only a violent increase of the malady. As soon as I became acquainted with the

situation and extent of this irruption of cholera, I suspected some contamination of the water of the much-frequented street-pump in Broad Street, near the end of Cambridge Street; but on examining the water, on the evening of the 3rd September, I found so little impurity in it of an organic nature, that I hesitated to come to a conclusion. Further inquiry, however, showed me that there was no other circumstance or agent common to the circumscribed locality in which this sudden increase of cholera occurred, and not extending beyond it, except the water of the above mentioned pump. I found, moreover, that the water varied, during the next two days, in the amount of organic impurity, visible to the naked eye, on close inspection, in the form of small white, flocculent particles; and I concluded that, at the commencement of the outbreak, it might possibly have been still more impure. I requested permission, therefore, to take a list, at the General Register Office, of the deaths from cholera, registered during the week ending 2nd September, in the sub-districts of Golden Square, Berwick Street, and St. Ann's, Soho, which was kindly granted. Eighty-nine deaths from cholera were registered, during the week, in the three subdistricts. Of these, only six occurred in the four first days of the week; four occurred on Thursday, the 31st August; and the remaining seventy-nine on Friday and Saturday. I considered, therefore, that the outbreak commenced on the Thursday; and I made inquiry, in detail, respecting the eighty-three deaths registered as having taken place during the last three days of the week.

On proceeding to the spot, I found that nearly all the deaths had taken place within a short distance of the pump. There were only ten deaths in houses situated decidedly nearer to another street pump. In five of these cases the families of the deceased persons informed me

that they always sent to the pump in Broad Street, as they preferred the water to that of the pump which was nearer. In three other cases, the deceased were children who went to school near the pump in Broad Street. Two of them were known to drink the water ; and the parents of the third think it probable that it did so. The other two deaths, beyond the district which this pump supplies, represent only the amount of mortality from cholera that was occurring before the irruption took place.

With regard to the deaths occurring in the locality belonging to the pump, there were sixty-one instances in which I was informed that the deceased persons used to drink the pump-water from Broad Street, either constantly or occasionally. In six instances I could get no information, owing to the death or departure of every one connected with the deceased individuals ; and in six cases I was informed that the deceased persons did not drink the pump-water before their illness.

The result of the inquiry then was, that there had been no particular outbreak or increase of cholera, in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump-well.

I had an interview with the Board of Guardians of St. James's parish, on the evening of Thursday, 7th September, and represented the above circumstances to them. In consequence of what I said, the handle of the pump was removed on the following day.

Besides the eighty-three deaths mentioned above as occurring on the three last days of the week ending September 2nd, and being registered during that week in the sub-districts in which the attacks occurred, a number of persons died in Middlesex and other hospitals, and a great number of deaths which took place in the

locality during the last two days of the week, were not registered till the week following. The deaths altogether, on the 1st and 2nd of September, which have been ascertained to belong to this outbreak of cholera, were one hundred and ninety-seven; and many persons who were attacked about the same time as these, died afterwards. I should have been glad to inquire respecting the use of the water from Broad Street pump in all these instances, but was engaged at the time in an inquiry in the south districts of London, which will be alluded to afterwards; and when I began to make fresh inquiries in the neighbourhood of Golden Square, after two or three weeks had elapsed, I found that there had been such a distribution of the remaining population that it would be impossible to arrive at a complete account of the circumstances. There is no reason to suppose, however, that a more extended inquiry would have yielded a different result from that which was obtained respecting the eighty-three deaths which happened to be registered within the district of the outbreak before the end of the week in which it occurred.

The additional facts that I have been able to ascertain are in accordance with those above related; and as regards the small number of those attacked, who were believed not to have drank the water from Broad Street pump, it must be obvious that there are various ways in which the deceased persons may have taken it without the knowledge of their friends. The water was used for mixing with spirits in all the public houses around. It was used likewise at dining-rooms and coffee-shops. The keeper of a coffee-shop in the neighbourhood, which was frequented by mechanics, and where the pump-water was supplied at dinner time, informed me (on 6th September) that she was already aware of nine of her customers who

were dead. The pump-water was also sold in various little shops, with a teaspoonful of effervescing powder in it, under the name of sherbet; and it may have been distributed in various other ways with which I am unacquainted. The pump was frequented much more than is usual, even for a London pump in a populous neighbourhood.

There are certain circumstances bearing on the subject of this outbreak of cholera which require to be mentioned. The Workhouse in Poland Street is more than three-fourths surrounded by houses in which deaths from cholera occurred, yet out of five hundred and thirty-five inmates only five died of cholera, the other deaths which took place being those of persons admitted after they were attacked. The workhouse has a pump-well on the premises, in addition to the supply from the Grand Junction Water Works, and the inmates never sent to Broad Street for water. If the mortality in the workhouse had been equal to that in the streets immediately surrounding it on three sides, upwards of one hundred persons would have died.

There is a Brewery in Broad Street, near to the pump, and on perceiving that no brewer's men were registered as having died of cholera, I called on Mr. Huggins, the proprietor. He informed me that there were above seventy workmen employed in the brewery, and that none of them had suffered from cholera,—at least in a severe form,—only two having been indisposed, and that not seriously, at the time the disease prevailed. The men are allowed a certain quantity of malt liquor, and Mr. Huggins believes they do not drink water at all; and he is quite certain that the workmen never obtained water from the pump in the street. There is a deep well in the brewery, in addition to the New River water.

At the percussion-cap manufactory, 37 Broad Street, where, I understand, about two hundred workpeople were employed, two tubs were kept on the premises always supplied with water from the pump in the street, for those to drink who wished ; and eighteen of these workpeople died of cholera at their own homes, sixteen men and two women.

Mr. Marshall, surgeon, of Greek Street, was kind enough to inquire respecting seven workmen who had been employed in the manufactory of dentists' materials, at Nos. 8 and 9 Broad Street, and who died at their own homes. He learned that they were all in the habit of drinking water from the pump, generally drinking about half-a-pint once or twice a day ; while two persons who reside constantly on the premises, but do not drink the pump-water, only had diarrhœa. Mr. Marshall also informed me of the case of an officer in the army, who lived at St. John's Wood, but came to dine in Wardour Street, where he drank the water from Broad Street pump at his dinner. He was attacked with cholera, and died in a few hours.

I am indebted to Mr. Marshall for the following cases, which are interesting as showing the period of incubation, which in these three cases was from thirty-six to forty-eight hours. Mrs. —, of 13 Bentinck Street, Berwick Street, aged 28, in the eighth month of pregnancy, went herself (although they were not usually water drinkers), on Sunday, 3rd September, to Broad Street pump for water. The family removed to Gravesend on the following day ; and she was attacked with cholera on Tuesday morning at seven o'clock, and died of consecutive fever on 15th September, having been delivered. Two of her children drank also of the water, and were attacked on the same day as the mother, but recovered.

Dr. Fraser, of Oakley Square, kindly informed me of the following circumstance. A gentleman in delicate health was sent for from Brighton to see his brother at 6 Poland Street, who was attacked with cholera and died in twelve hours, on 1st September. The gentleman arrived after his brother's death, and did not see the body. He only stayed about twenty minutes in the house, where he took a hasty and scanty luncheon of rumpsteak, taking with it a small tumbler of brandy and water, the water being from Broad Street pump. He went to Pentonville, and was attacked with cholera on the evening of the following day, 2nd September, and died the next evening.

Dr. Fraser also first called my attention to the following circumstances, which are perhaps the most conclusive of all in proving the connexion between the Broad Street pump and the outbreak of cholera. In the "Weekly Return of Births and Deaths" of September 9th, the following death is recorded as occurring in the Hampstead district: "At West End, on 2nd September, the widow of a percussion-cap maker, aged 59 years, diarrhœa two hours, cholera epidemica sixteen hours."

I was informed by this lady's son that she had not been in the neighbourhood of Broad Street for many months. A cart went from Broad Street to West End every day, and it was the custom to take out a large bottle of the water from the pump in Broad Street, as she preferred it. The water was taken on Thursday, 31st August, and she drank of it in the evening, and also on Friday. She was seized with cholera on the evening of the latter day, and died on Saturday, as the above quotation from the register shows. A niece, who was on a visit to this lady, also drank of the water; she returned to her residence, in a high and healthy part of Islington, was attacked with cholera, and died also. There was no cholera at the time,





either at West End or in the neighbourhood where the niece died. Besides these two persons, only one servant partook of the water at Hampstead West End, and she did not suffer, or, at least, not severely. There were many persons who drank the water from Broad Street pump about the time of the outbreak, without being attacked with cholera ; but this does not diminish the evidence respecting the influence of the water, for reasons that will be fully stated in another part of this work.

The deaths which occurred during this fatal outbreak of cholera are indicated in the accompanying map, as far as I could ascertain them. There are necessarily some deficiencies, for in a few of the instances of persons who died in the hospitals after their removal from the neighbourhood of Broad Street, the number of the house from which they had been removed was not registered. The address of those who died after their removal to St. James's Workhouse was not registered ; and I was only able to obtain it, in a part of the cases, on application at the Master's Office, for many of the persons were too ill, when admitted, to give any account of themselves. In the case also of some of the workpeople and others who contracted the cholera in this neighbourhood, and died in different parts of London, the precise house from which they had removed is not stated in the return of deaths. I have heard of some persons who died in the country shortly after removing from the neighbourhood of Broad Street ; and there must, no doubt, be several cases of this kind that I have not heard of. Indeed, the full extent of the calamity will probably never be known. The deficiencies I have mentioned, however, probably do not detract from the correctness of the map as a diagram of the topography of the outbreak ; for, if the locality of the few additional cases could be ascertained, they would probably be distri-

tributed over the district of the outbreak in the same proportion as the large number which are known.

The dotted line on the map surrounds the sub-districts of Golden Square, St. James's, and Berwick Street, St. James's, together with the adjoining portion of the sub-district of St. Anne, Soho, extending from Wardour Street to Dean Street, and a small part of the sub-district of St. James's Square enclosed by Marylebone Street, Titchfield Street, Great Windmill Street, and Brewer Street. All the deaths from cholera which were registered in the six weeks from 19th August to 30th September within this locality, as well as those of persons removed into Middlesex Hospital, are shown in the map* by a black line in the situation of the house in which it occurred, or in which the fatal attack was contracted.

In addition to these the deaths of persons removed to University College Hospital, to Charing Cross Hospital, and to various parts of London, are indicated in the map, where the exact address was given in the "Weekly Return of Deaths," or, when I could learn it by private inquiry.

The pump in Broad Street is indicated on the map, as well as all the surrounding pumps to which the public had access at the time. It requires to be stated that the water of the pump in Marlborough Street, at the end of Carnaby Street, was so impure that many people avoided using it. And I found that the persons who died near this pump in the beginning of September, had water from the Broad Street pump. With regard to the pump in Rupert Street, it will be noticed that some streets which are near to it on the map, are in fact a good way removed, on

* The particulars of each death connected with this outbreak were published in the "Weekly Returns" of the Registrar-General to 16th September, and I procured the remainder through the kindness of the Registrar-General and the District Registrars.

account of the circuitous road to it. These circumstances being taken into account, it will be observed that the deaths either very much diminished, or ceased altogether, at every point where it becomes decidedly nearer to send to another pump than to the one in Broad Street. It may also be noticed that the deaths are most numerous near to the pump where the water could be more readily obtained. The wide open street in which the pump is situated suffered most, and next the streets branching from it, and especially those parts of them which are nearest to Broad Street. If there have been fewer deaths in the south half of Poland Street than in some other streets leading from Broad Street, it is no doubt because this street is less densely inhabited.

In some of the instances, where the deaths are scattered a little further from the rest on the map, the malady was probably contracted at a nearer point to the pump. A cabinet-maker, who was removed from Philip's Court, Noel Street, to Middlesex Hospital, worked in Broad Street. A boy also who died in Noel Street, went to the National school at the end of Broad Street, and having to pass the pump, probably drank of the water. A tailor, who died at 6, Heddon Court, Regent Street, spent most of his time in Broad Street. A woman, removed to the hospital from 10, Heddon Court, had been nursing a person who died of cholera in Marshall Street. A little girl, who died in Ham Yard, and another who died in Angel Court, Great Windmill Street, went to the school in Dufour's Place, Broad Street, and were in the habit of drinking the pump-water, as were also a child from Naylor's Yard, and several others, who went to this and other schools near the pump in Broad Street. A woman who died at 2, Great Chapel Street, Oxford Street, had been occupied for two days preceding her illness at the

public washhouses near the pump, and used to drink a good deal of water whilst at her work ; the water drank there being sometimes from the pump and sometimes from the cistern.

The limited district in which this outbreak of cholera occurred, contains a great variety in the quality of the streets and houses ; Poland Street and Great Pulteney Street consisting in a great measure of private houses occupied by one family, whilst Husband Street and Peter Street are occupied chiefly by the poor Irish. The remaining streets are intermediate in point of respectability. The mortality appears to have fallen pretty equally amongst all classes, in proportion to their numbers. Masters are not distinguished from journeymen in the registration returns of this district, but, judging from my own observation, I consider that out of rather more than six hundred deaths, there were about one hundred in the families of tradesmen and other resident householders. One hundred and five persons who had been removed from this district died in Middlesex, University College, and other hospitals, and two hundred and six persons were buried at the expense of St. James's parish ; the latter number includes many of those who died in the hospitals, and a great number who were far from being paupers, and would on any other occasion have been buried by their friends, who, at this time, were either not aware of the calamity or were themselves overwhelmed by it. The greatest portion of the persons who died were tailors and other operatives, who worked for the shops about Bond Street and Regent Street, and the wives and children of these operatives. They were living chiefly in rooms which they rented by the week.

The following table exhibits the chronological features of this terrible outbreak of cholera.

TABLE I.

Date.	No. of Fatal Attacks.								Deaths.
August	19	...	...	...	1	...	...	...	1
"	20	...	...	...	1	...	...	...	0
"	21	...	...	...	1	...	...	...	2
"	22	...	...	...	0	...	...	...	0
"	23	...	...	...	1	...	...	...	0
"	24	...	...	...	1	...	...	...	2
"	25	...	...	...	0	...	...	...	0
"	26	...	...	...	1	...	...	...	0
"	27	...	...	...	1	...	...	...	1
"	28	...	...	...	1	...	...	...	0
"	29	...	...	...	1	...	...	...	1
"	30	...	...	...	8	...	...	...	2
"	31	...	...	...	56	...	...	...	3
September	1	...	...	...	143	...	...	...	70
"	2	...	...	...	116	...	...	...	127
"	3	...	...	...	54	...	...	...	76
"	4	...	...	...	46	...	...	...	71
"	5	...	...	...	36	...	...	...	45
"	6	...	...	...	20	...	...	...	37
"	7	...	...	...	28	...	...	...	32
"	8	...	...	...	12	...	...	...	30
"	9	...	...	...	11	...	...	...	24
"	10	...	...	...	5	...	...	...	18
"	11	...	...	...	5	...	...	...	15
"	12	...	...	...	1	...	...	...	6
"	13	...	...	...	3	...	...	...	13
"	14	...	...	...	0	...	...	...	6
"	15	...	...	...	1	...	...	...	8
"	16	...	...	...	4	...	...	...	6
"	17	...	...	...	2	...	...	...	5
"	18	...	...	...	3	...	...	...	2
"	19	...	...	...	0	...	...	...	3
"	20	...	...	...	0	...	...	...	0
"	21	...	...	...	2	...	...	...	0
"	22	...	...	...	1	...	...	...	2
"	23	...	...	...	1	...	...	...	3
"	24	...	...	...	1	...	...	...	0
"	25	...	...	...	1	...	...	...	0
"	26	...	...	...	1	...	...	...	2
"	27	...	...	...	1	...	...	...	0
"	28	...	...	...	0	...	...	...	2
"	29	...	...	...	0	...	...	...	1
"	30	...	...	...	0	...	...	...	0
Date unknown	...	...	...	...	45	...	...	...	0
Total				...	616				616

The deaths in the above table are compiled from the sources mentioned above in describing the map ; but some deaths which were omitted from the map on account of the number of the house not being known, are included in the table. As regards the date of attack, I was able to obtain it with great precision, through the kindness of Mr. Sibley, in upwards of eighty deaths which occurred in Middlesex Hospital ; for the hour of admission was entered in the hospital books, as well as the previous duration of the illness. In a few other cases also I had exact information of the hour of attack, and in the remainder I have calculated it by subtracting the duration of the illness from the date of death. Where the illness did not exceed twelve hours, the attack was considered to have commenced the same day ; where the illness exceeded twelve, and did not exceed thirty-six hours, the attack was put down to the previous day, and so on. Where the illness exceeded forty-eight hours, its duration is generally given in days, which were subtracted from the date of the attack. Although this plan does not always give the precise date of attack, it reaches within a few hours of it, and is as valuable perhaps as if the exact day were given, unless the hour as well as the day could be introduced into the table. Where premonitory diarrhœa is stated to have existed, the period of its duration is deducted from the date of death, and, in fact, the time of attack is fixed at the first commencement of indisposition, except in two or three instances in which the patient was labouring under another disease, as phthisis or typhus fever. There are forty-five cases in which the duration of the illness was not certified, or entered in the books of the registrars, and the time of attack in these cases is consequently unknown. These persons nearly all died in the first days of September, in

the height of the calamity, and it is almost certain that they were cut off very quickly, like the others who died at this time.

It is pretty certain that very few of the fifty-six attacks placed in the table to the 31st August occurred till late in the evening of that day. The irruption was extremely sudden, as I learn from the medical men living in the midst of the district, and commenced in the night between the 31st August and 1st September. There was hardly any premonitory diarrhœa in the cases which occurred during the first three days of the outbreak ; and I have been informed by several medical men, that very few of the cases which they attended on those days ended in recovery.

The greatest number of attacks in any one day occurred on the 1st of September, immediately after the outbreak commenced. The following day the attacks fell from one hundred and forty-three to one hundred and sixteen, and the day afterwards to fifty-four. A glance at the above table will show that the fresh attacks continued to become less numerous every day. On September the 8th—the day when the handle of the pump was removed—there were twelve attacks ; on the 9th, eleven ; on the 10th, five ; on the 11th, five ; on the 12th, only one ; and after this time, there were never more than four attacks on one day. During the decline of the epidemic the deaths were more numerous than the attacks, owing to the decease of many persons who had lingered for several days in consecutive fever.

There is no doubt that the mortality was much diminished, as I said before, by the flight of the population, which commenced soon after the outbreak ; but the attacks had so far diminished before the use of the water was stopped, that it is impossible to decide whether the well

still contained the cholera poison in an active state, or whether, from some cause, the water had become free from it. The pump-well has been opened, and I was informed by Mr. Farrell, the superintendent of the works, that there was no hole or crevice in the brickwork of the well, by which any impurity might enter; consequently in this respect the contamination of the water is not made out by the kind of physical evidence detailed in some of the instances previously related. I understand that the well is from twenty-eight to thirty feet in depth, and goes through the gravel to the surface of the clay beneath. The sewer, which passes within a few yards of the well, is twenty-two feet below the surface. The water at the time of the cholera contained impurities of an organic nature, in the form of minute whitish flocculi visible on close inspection to the naked eye, as I before stated. Dr. Hassall, who was good enough to examine some of this water with the microscope, informed me that these particles had no organised structure, and that he thought they probably resulted from decomposition of other matter. He found a great number of very minute oval animalcules in the water, which are of no importance, except as an additional proof that the water contained organic matter on which they lived. The water also contained a large quantity of chlorides, indicating, no doubt, the impure sources from which the spring is supplied. Mr. Eley, the percussion-cap manufacturer of 37 Broad Street, informed me that he had long noticed that the water became offensive, both to the smell and taste, after it had been kept about two days. This, as I noticed before, is a character of water contaminated with sewage. Another person had noticed for months that a film formed on the surface of the water when it had been kept a few hours.

I inquired of many persons whether they had observed

any change in the character of the water, about the time of the outbreak of cholera, and was answered in the negative. I afterwards, however, met with the following important information on this point. Mr. Gould, the eminent ornithologist, lives near the pump in Broad Street, and was in the habit of drinking the water. He was out of town at the commencement of the outbreak of cholera, but came home on Saturday morning, 2nd September, and sent for some of the water almost immediately, when he was much surprised to find that it had an offensive smell, although perfectly transparent and fresh from the pump. He did not drink any of it. Mr. Gould's assistant, Mr. Prince, had his attention drawn to the water, and perceived its offensive smell. A servant of Mr. Gould who drank the pump water daily, and drank a good deal of it on August 31st, was seized with cholera at an early hour on September 1st. She ultimately recovered.

Whether the impurities of the water were derived from the sewers, the drains, or the cesspools, of which latter there are a number in the neighbourhood, I cannot tell. I have been informed by an eminent engineer, that whilst a cesspool in a clay soil requires to be emptied every six or eight months, one sunk in the gravel will often go for twenty years without being emptied, owing to the soluble matters passing away into the land-springs by percolation. As there had been deaths from cholera just before the great outbreak not far from this pump-well, and in a situation elevated a few feet above it, the evacuations from the patients might of course be amongst the impurities finding their way into the water, and judging the matter by the light derived from other facts and considerations previously detailed, we must conclude that such was the case. A very important point in respect to this pump-well is that the water passed with almost everybody as being

perfectly pure, and it did in fact contain a less quantity of impurity than the water of some other pumps in the same parish, which had no share in the propagation of cholera. We must conclude from this outbreak that the quantity of morbid matter which is sufficient to produce cholera is inconceivably small, and that the shallow pump-wells in a town cannot be looked on with too much suspicion, whatever their local reputation may be.

Whilst the presumed contamination of the water of the Broad Street pump with the evacuations of cholera patients affords an exact explanation of the fearful outbreak of cholera in St. James's parish, there is no other circumstance which offers any explanation at all, whatever hypothesis of the nature and cause of the malady be adopted. Many persons were inclined to attribute the severity of the malady in this locality to the very circumstance to which some people attribute the comparative immunity of the city of London from the same disease, viz., to the drains in the neighbourhood having been disturbed and put in order about half a year previously. Mr. Bazelgette, however, pointed out, in a report to the commissioners, that the streets in which the new sewers had been made suffered less than the others; and a reference to the map will show that this is correct, for I recollect that the streets in which the sewers were repaired about February last, were Brewer Street, Little Pulteney Street, and Dean Street, Soho. Many of the non-medical public were disposed to attribute the outbreak of cholera to the supposed existence of a pit in which persons dying of the plague had been buried about two centuries ago; and, if the alleged plague-pit had been nearer to Broad Street, they would no doubt still cling to the idea. The situation of the supposed pit is, however, said to be Little Marlborough Street, just out of the area in which the chief mortality

occurred. With regard to effluvia from the sewers passing into the streets and houses, that is a fault common to most parts of London and other towns. There is nothing peculiar in the sewers or drainage of the limited spot in which this outbreak occurred ; and Saffron Hill and other localities, which suffer much more from ill odours, have been very lightly visited by cholera.

Just at the time when the great outbreak of cholera occurred in the neighbourhood of Broad Street, Golden Square, there was an equally violent irruption in Deptford, but of a more limited extent. About ninety deaths took place in a few days, amongst two or three score of small houses, in the north end of New Street and an adjoining row called French's Fields. Deptford is supplied with very good water from the river Ravensbourne by the Kent Water Works, and until this outbreak there was but little cholera in the town, except amongst some poor people, who had no water except what they got by pailsful from Deptford Creek—an inlet of the Thames. There had, however, been a few cases in and near New Street, just before the great outbreak. On going to the spot on September 12th and making inquiry, I found that the houses in which the deaths had occurred were supplied by the Kent Water Works, and the inhabitants never used any other water. The people informed me, however, that for some few weeks the water had been extremely offensive when first turned on ; they said it smelt like a cesspool, and frothed like soap suds. They were in the habit of throwing away a few pailsful of that which first came in, and collecting some for use after it became clear. On inquiring in the surrounding streets, to which this outbreak of cholera did not extend, viz., Wellington Street, Old King Street, and Hughes's Fields, I found that there had been no alteration in the water. I con-

cluded, therefore, that a leakage had taken place into the pipes supplying the places where the outbreak occurred, during the intervals when the water was not turned on. Gas is known to get into the water-pipes occasionally in this manner, when they are partially empty, and to impart its taste to the water. There are no sewers in New Street or French's Fields, and the refuse of all kinds consequently saturates the ground in which the pipes are laid. I found that the water collected by the people, after throwing away the first portion, still contained more organic matter than that supplied to the adjoining streets. On adding nitrate of silver and exposing the specimens to the light, a deeper tint of brown was developed in the former than in the latter.

All the instances of communication of cholera through the medium of water, above related, have resulted from the contamination of a pump-well, or some other limited supply of water ; and the outbreaks of cholera connected with the contamination, though sudden and intense, have been limited also ; but when the water of a river becomes infected with the cholera evacuations emptied from on board ship, or passing down drains and sewers, the communication of the disease, though generally less sudden and violent, is much more widely extended ; more especially when the river water is distributed by the steam engine and pipes connected with water-works. Cholera may linger in the courts and alleys crowded with the poor, for reasons previously pointed out, but I know of no instance in which it has been generally spread through a town or neighbourhood, amongst all classes of the community, in which the drinking water has not been the medium of its diffusion. Each epidemic of cholera in London has borne a strict relation to the nature of the

water-supply of its different districts, being modified only by poverty, and the crowding and want of cleanliness which always attend it.

The following table shows the number of deaths from cholera in the various districts of London in 1832, together with the nature of the water supply at that period. (See next page.)*

This table shows that in the greater part of Southwark, which was supplied with worse water than any other part of the metropolis, the mortality from cholera was also much higher than anywhere else. The other south districts, supplied with water obtained at points higher up the Thames, and containing consequently less impurity, were less affected. On the north of the Thames, the east districts, supplied, in 1832, with water from the river Lea, at Old Ford, where it contained the sewage of a large population, suffered more than other parts on the north side of London. Whitechapel suffered more than the other east districts ; probably not more from the poverty and crowded state of the population, than from the great number of mariners, coalheavers, and others, living there, who were employed on the Thames, and got their water, whilst at work, direct from the river. There were one hundred and thirty-nine deaths from cholera amongst persons afloat on the Thames. The cholera passed very lightly over most of the districts supplied by the New River Company. St Giles' was an exception, owing to the overcrowding of the common lodging-houses in the part of the parish called the Rookery. The City of London also suffered severely in 1832. Now when the engine at Broken Wharf was employed to draw water from the Thames, this water was supplied more particularly

* The deaths are obtained from the "First Report of the Metropolitan Sanitary Commission", 1847 ; and the water-supply, chiefly from a work entitled "Hydraulia", by William Matthews, 1835.

TABLE II.

Districts.	Population.	Deaths from Cholera.	Deaths from Cholera in 10,000 living.	Water Supply.
St. George the Martyr, Southwark	77,796	856	110	Southwark Water Works, from Thames at London Bridge. No filter or settling reservoir.
St. Olave's, Southwark				
St. Saviour's, Southwark				
Christchurch, Southwark	13,705	35	25	Chiefly by Lambeth Water Works, from Thames opposite Hungerford Market. No filter or settling reservoir.
Lambeth	87,856	337	38	
Newington	44,526	200	45	Chiefly by South London Water Works, from Thames at Vauxhall Bridge. Re-servoirs. No filter.
Camberwell	28,231	107	37	
Bermondsey	29,741	210	70	South London Water Works, and Tidal Ditches.
Rotherhithe	12,875	19	14	
Bethnal Green	62,018	170	27	East London Water Works, from tidal part of river Lea at Old Ford.
St. George-in-the-East	38,505	123	31	
Poplar	25,066	107	42	
Stepney	78,826	225	28	
Whitechapel*	52,848	470	88	

Clerkenwell	.	.	.	47,634	65	13	<div> <div>34</div> </div>	<div> New River Company, from various springs, and river Lea in Hertfordshire; and occasionally from Thames at Broken Wharf, near Blackfriar's Bridge. </div>
St. Giles	.	.	.	52,907	280	52		
Holborn	.	.	.	27,334	46	16		
Islington	.	.	.	37,316	39	10		
London City	.	.	.	55,798	359	64		
East and West London	.	.	.	No return.	—	—		
St. Luke's	.	.	.	46,642	118	25		
Strand	.	.	.	9,937	37	37		
Hackney	.	.	.	7,326	8	10	<div> </div>	<div> New River and East London Water Companies. </div>
Shoreditch	.	.	.	68,564	57	8		
Westminster	.	.	.	124,585	325	26	<div> </div>	<div> Chelsea Water Works, from Thames at Chelsea. Reservoirs and filters. </div>
St. George, Hanover Square	.	.	.	58,209	74	12		
Kensington	.	.	.	75,130	134	17	<div> 15 </div>	<div> Chelsea Water Works and Grand Junction Water Works, also supplying water from Thames at Chelsea, and having settling reservoirs. </div>
St. Marylebone	.	.	.	122,206	224	20	<div> </div>	<div> West Middlesex Water Works, from Thames at Hammersmith. Settling reservoirs. </div>
St. Pancras	.	.	.	103,548	111	10	<div> </div>	<div> West Middlesex, New River, and Hampstead Water Works. </div>

* A small part of the Whitechapel District is supplied with New River water.

to the City, and not at all to the higher districts supplied by the New River Company. This would offer an explanation of the high mortality from cholera in the City at that time, supposing the engine were actually used during 1832 ; but I have not yet been able to ascertain that circumstance with certainty. I know, however, that it was still used occasionally some years later.

Westminster suffered more in 1832 than St. George, Hanover Square, and Kensington, which at that time had the same water. This arose from the poor and crowded state of part of its population. The number of cases of cholera communicated by the water would be the same in one district as in the other ; but in one district the disease would spread also from person to person more than in the others.

Between 1832 and 1849 many changes took place in the water-supply of London. The Southwark Water Company united with the South London Water Company, to form a new Company under the name of the Southwark and Vauxhall Company. The water works at London Bridge were abolished, and the united company derived their supply from the Thames at Battersea Fields, about half-a-mile above Vauxhall Bridge. The Lambeth Water Company continued to obtain their supply opposite to Hungerford Market ; but they had established a small reservoir at Brixton.

But whilst these changes had been made by the water companies, changes still greater had taken place in the river, partly from the increase of population, but much more from the abolition of cesspools and the almost universal adoption of waterclosets in their stead. The Thames in 1849 was more impure at Battersea Fields than it had been in 1832 at London Bridge. A clause which prevented the South London Water Company from laying their pipes within two miles of the Lambeth Water Works was repealed in 1834, and the two Companies were in

active competition for many years, the result of which is, that the pipes of the Lambeth Water Company and those of the Southwark and Vauxhall Company pass together down all the streets of several of the south districts. As the water of both these Companies was nearly equal in its impurity in 1849, this circumstance was of but little consequence at that time ; but it will be shown further on that it afterwards led to very important results.

On the north side of the Thames the Water Companies and their districts remained the same, but some alterations were made in the sources of supply. The East London Water Company ceased to obtain water at Old Ford, and got it from the river Lea, above Lea Bridge, out of the influence of the tide and free from sewage, except that from some part of Upper Clapton. The Grand Junction Company removed their works from Chelsea to Brentford, where they formed large settling reservoirs. The New River Company entirely ceased to employ the steam-engine for obtaining water from the Thames. The supply of the other Water Companies remained the same as in 1832.

The accompanying table (No. 3), shows the mortality from cholera in the various registration districts of London in 1849, together with the water supply. The annual value of house and shop-room for each person is also shown, as a criterion, to a great extent, of the state of overcrowding or the reverse. The deaths from cholera and the value of house-room, are taken from the " Report on the Cholera of 1849," by Dr. Farr, of the General Register Office. The water supply is indicated merely by the name of the Companies. After the explanation given above of the source of supply, this will be sufficient. It is only necessary to add, that the Kent Water Company derive their supply from the river Ravensbourne, and the Hampstead Company from springs and reservoirs at Hampstead.

TABLE III,

Showing the mortality from Cholera, and the Water Supply, in the Districts of London, in 1849.
The Districts are arranged in the order of their Mortality from Cholera.

District.	Population in the middle of 1849.	Deaths from Cholera.	Deaths by Cholera to 10,000 inhabits.	Annual value of House & Shop room to each person in £.	Water Supply.
Rotherhithe	17,208	352	205	4.238	Southwark and Vauxhall Water Works, Kent Water Works, and Tidal Ditches.
St. Olave, Southwark	19,278	349	181	4.559	Southwark and Vauxhall.
St. George, Southwark	50,900	836	164	3.518	Southwark and Vauxhall, Lambeth.
Bermondsey	45,500	734	161	3.077	Southwark and Vauxhall.
St. Saviour, Southwark	35,227	539	153	5.291	Southwark and Vauxhall.
Newington	63,074	907	144	3.788	Southwark and Vauxhall, Lambeth.
Lambeth	134,768	1618	120	4.389	Southwark and Vauxhall, Lambeth.
Wandsworth	48,446	484	100	4.839	{ Pump-wells, Southwark and Vauxhall, river Wandle.
Camberwell	51,714	504	97	4.508	Southwark and Vauxhall, Lambeth.
West London	28,829	429	96	7.454	New River.
Bethnal Green	87,263	789	90	1.480	East London.
Shoreditch	104,122	789	76	3.103	New River, East London.
Greenwich	95,954	718	75	3.379	Kent.
Poplar	44,103	313	71	7.360	East London.
Westminster	64,109	437	68	4.189	Chelsea.
Whitechapel	78,590	506	64	3.388	East London.

St. Giles	.	.	.	54,062	285	53	5.635	New River.
Stepney	.	.	.	106,988	501	47	3.319	East London.
Chelsea	.	.	.	53,379	247	46	4.210	Chelsea.
East London	.	.	.	43,495	182	45	4.823	New River.
St. George's, East	.	.	.	47,334	199	42	4.753	East London.
London City	.	.	.	55,816	207	38	17.676	New River.
St. Martin	.	.	.	24,557	91	37	11.844	New River.
Strand	.	.	.	44,254	156	35	7.374	New River.
Holborn	.	.	.	46,134	161	35	5.883	New River.
St. Luke	.	.	.	53,234	183	34	3.731	New River.
Kensington (except Paddington)	.	.	.	110,491	260	33	5.070	West Middlesex, Chelsea, Grand Junction.
Lewisham	.	.	.	32,299	96	30	4.824	Kent.
Belgrave	.	.	.	37,918	105	28	8.875	Chelsea.
Hackney	.	.	.	55,152	139	25	4.397	New River, East London.
Islington	.	.	.	87,761	187	22	5.494	New River.
St. Pancras	.	.	.	160,122	360	22	4.871	New River, Hampstead, West Middlesex.
Clerkenwell	.	.	.	63,499	121	19	4.138	New River.
Marylebone	.	.	.	153,960	261	17	7.586	West Middlesex.
St. James, Westminster	.	.	.	36,426	57	16	12.669	Grand Junction, New River.
Paddington	.	.	.	41,267	35	8	9.349	Grand Junction.
Hampstead	.	.	.	11,572	9	8	5.804	Hampstead, West Middlesex.
Hanover Square & May Fair	.	.	.	33,196	26	8	16.754	Grand Junction.
London	.	.	.	2,280,282	14137	62	—	

A glance at the table shows that in every district to which the supply of the Southwark and Vauxhall, or the Lambeth Water Company extends, the cholera was more fatal than in any other district whatever. The only other water company deriving a supply from the Thames, in a situation where it is much contaminated with the contents of the sewers, was the Chelsea Company. But this company, which supplies some of the most fashionable parts of London, took great pains to filter the water before its distribution, and in so doing no doubt separated, amongst other matters, the greater portion of that which causes cholera. On the other hand, although the Southwark and Vauxhall and the Lambeth Water Companies professed to filter the water, they supplied it in a most impure condition. Even in the following year, when Dr. Hassall made an examination of it, he found in it the hairs of animals and numerous substances which had passed through the alimentary canal. Speaking of the water supply of London generally, Dr. Hassall says :—

“ It will be observed, that the water of the companies on the Surrey side of London, viz., the Southwark, Vauxhall, and Lambeth, is by far the worst of all those who take their supply from the Thames.”*

In the north districts of London, which suffered much less from cholera than the south districts, the mortality was chiefly influenced by the poverty and crowding of the population. The New River Company having entirely left off the use of their engine in the city, their water, being entirely free from sewage, could have had no share in the propagation of cholera. It is probable also, that the water of the East London Company, obtained above Lea Bridge, had no share in propagating the malady ; and

* A Microscopic Examination of the Water supplied to London. London : 1850.

that this is true also of the West Middlesex Company, obtaining their supply from the Thames at Hammersmith ; and of the Grand Junction Company, obtaining their supply at Brentford. All these Water Companies have large settling reservoirs. It is probable also, as I stated above, that the Chelsea Company in 1849, by careful filtration and by detaining the water in their reservoirs, rendered it in a great degree innocuous.

Some parts of London suffered by the contamination of the pump-wells in 1849, and the cholera in the districts near the river was increased by the practice, amongst those who are occupied on the Thames, of obtaining water to drink by dipping a pail into it. It will be shown further on, that persons occupied on the river suffered more from cholera than others. Dr. Baly makes the following inquiry in his Report to the College of Physicians.*

“ How did it happen, if the character of the water has a great influence on the mortality from cholera, that in the Belgrave district only 28 persons in 10,000 died, and in the Westminster district, also supplied by the Chelsea Company, 68 persons in 10,000 ; and, again, that in the Wandsworth district the mortality was only 100, and in the district of St. Olave 181 in 10,000 inhabitants—both these districts receiving their supply from the Southwark Company ? ”

The water of the Chelsea Company has been alluded to above, but whether this water had any share in the propagation of cholera or not, it is perfectly in accordance with the mode of communication of the disease

* P. 207. In the table at page 206, Dr. Baly has fallen into the mistake of supposing that the Lambeth Water Company obtained their supply from Thames Ditton in 1849. It was not till 1852 that their works were removed to that place. Dr. Baly has also mistaken the name and identity of all the three Companies which supply the south districts of London with water.

which I am advocating, that it should spread more in the crowded habitations of the poor, in Westminster, than in the commodious houses of the Belgrave district. In examining the effect of polluted water as a medium of the cholera poison, it is necessary to bear constantly in mind the more direct way in which the poison is also swallowed, as I explained in the commencement of this work. As regards St. Olave's and Wandsworth, Dr. Baly was apparently not aware that, whilst almost every house in the first of these districts is supplied by the water company, and has no other supply, the pipes of the company extend to only a part of the Wandsworth district, a large part of it having only pump-wells.

The epidemic of 1849 was a continuance or revival of that which commenced in the autumn of 1848, and there are some circumstances connected with the first cases which are very remarkable, and well worthy of notice. It has been already stated (page 3) that the first case of decided Asiatic cholera in London, in the autumn of 1848, was that of a seaman from Hamburgh, and that the next case occurred in the very room in which the first patient died. These cases occurred in Horsleydown, close to the Thames. In the evening of the day on which the second case occurred in Horsleydown, a man was taken ill in Lower Fore Street, Lambeth, and died on the following morning. At the same time that this case occurred in Lambeth, the first of a series of cases occurred in White Hart Court, Duke Street, Chelsea, near the river. A day or two afterwards, there was a case at 3, Harp Court, Fleet Street. The next case occurred on October 2nd, on board the hulk *Justitia*, lying off Woolwich; and the next to this in Lower Fore Street, Lambeth, three doors from where a previous case had occurred. The first thirteen cases were all situated in the localities just

mentioned ; and on October 5th there were two cases in Spitalfields.

Now, the people in Lower Fore Street, Lambeth, obtained their water by dipping a pail into the Thames, there being no other supply in the street. In White Hart Court, Chelsea, the inhabitants obtained water for all purposes in a similar way. A well was afterwards sunk in the court ; but at the time these cases occurred the people had no other means of obtaining water, as I ascertained by inquiry on the spot. The inhabitants of Harp Court, Fleet Street, were in the habit, at that time, of procuring water from St. Bride's pump, which was afterwards closed on the representation of Mr. Hutchinson, surgeon, of Farringdon Street, in consequence of its having been found that the well had a communication with the Fleet Ditch sewer, up which the tide flows from the Thames. I was informed by Mr. Dabbs, that the hulk *Justitia* was supplied with spring-water from the Woolwich Arsenal ; but it is not improbable that water was occasionally taken from the Thames alongside, as was constantly the practice in some of the other hulks, and amongst the shipping generally.

When the epidemic revived again in the summer of 1849, the first case in the sub-district "Lambeth ; Church, 1st part," was in Lower Fore Street, on June 27th ; and on the commencement of the epidemic of the present year, the first case of cholera in any part of Lambeth, and one of the earliest in London, occurred at 52, Upper Fore Street, where also the people had no water except what they obtained from the Thames with a pail, as I ascertained by calling at the house. Many of the earlier cases this year occurred in persons employed amongst the shipping in the river, and the earliest cases in Wandsworth and Battersea have generally been amongst persons getting

water direct from the Thames, or from streams up which the Thames flows with the tide. It is quite in accordance with what might be expected from the propagation of cholera through the medium of the Thames water, that it should generally affect those who draw it directly from the river somewhat sooner than those who receive it by the more circuitous route of the pipes of a water company.

London was without cholera from the latter part of 1849 to August 1853. During this interval an important change had taken place in the water supply of several of the south districts of London. The Lambeth Company removed their water works, in 1852, from opposite Hungerford Market to Thames Ditton; thus obtaining a supply of water quite free from the sewage of London. The districts supplied by the Lambeth Company are, however, also supplied, to a certain extent, by the Southwark and Vauxhall Company, the pipes of both companies going down every street, in the places where the supply is mixed, as was previously stated. In consequence of this intermixing of the water supply, the effect of the alteration made by the Lambeth Company on the progress of cholera was not so evident, to a cursory observer, as it would otherwise have been. It attracted the attention, however, of the Registrar-General, who published a table in the "Weekly Return of Births and Deaths" for 26th November 1853, of which the following is an abstract, containing as much as applies to the south districts of London.

TABLE IV.

Water Companies.	Sources of Supply.	Aggregate of Districts supplied chiefly by the respective Companies.		Deaths in 100,000 inhabitants.
		Popula- tion.	Deaths by Cholera in 13 wks. end- ing Nov. 19.	
(1) Lambeth and (2) Southwark and Vauxhall.	Thames, at Thames Ditton and at Bat- tersea	346,363	211	61
Southwark and Vauxhall .	Thames, at Batter- sea	118,267	111	94
(1) Southwark and Vauxhall, (2) Kent .	Thames, at Batter- sea; the Ravens- bourne, in Kent, & ditches and wells .	17,805	19	107

It thus appears that the districts partially supplied with the improved water suffered much less than the others, although, in 1849, when the Lambeth Company obtained their supply opposite Hungerford Market, these same districts suffered quite as much as those supplied entirely by the Southwark and Vauxhall Company, as was shown in table III, p. 62. The Lambeth water extends to only a small portion of some of the districts necessarily included in the groups supplied by both Companies; and when the division is made a little more in detail, by taking sub-districts instead of districts, the effect of the new water supply is shown to be greater than appears in the above table. The Kent Water Company was introduced into the table by the Registrar-General on account of its supplying a small part of Rotherhithe. The following interesting remarks appeared, respecting this portion of Rotherhithe, in the "Weekly Return" of December 10, 1853 :—

"London Water Supply."—The following is an extract

from a letter which the Registrar-General has received from Mr. Pitt, the Registrar of Rotherhithe :—

“ ‘ I consider Mr. Morris’s description of the part of the parish through which the pipes of the Kent Water Company were laid in 1849, is in the main correct ; for though the Company had entered the parish, the water was but partially taken by the inhabitants up to the time of the fearful visitation in the above year.

“ ‘ With respect to the deaths in 1849, they were certainly more numerous in the district now generally supplied by the Kent Company than in any other part of the parish. I only need mention Charlotte Row, Ram Alley, and Silver Street,—places where the scourge fell with tremendous severity.

“ ‘ Among the recent cases of cholera, not one has occurred in the district supplied by the Kent Water Company.

“ ‘ The parish of Rotherhithe has been badly supplied with water for many ages past. The people drank from old wells, old pumps, open ditches, and the muddy stream of the Thames.’

“ In 1848-9 the mortality from cholera in Rotherhithe was higher than it was in any other district of London. This is quite in conformity with the general rule, that when cholera prevails, it is most fatal where the waters are most impure.”

The following table (which, with a little alteration in the arrangement, is taken from the “ Weekly Return of Births and Deaths” for 31st December 1853) shows the mortality from cholera, in the epidemic of 1853, down to a period when the disease had almost disappeared.

The districts are arranged in the order of their mortality from Cholera.

TABLE V.

Districts.	Population in 1853 (estimated).	Deaths by Chol. in 17 wks., Aug. 21 to Dec. 17, 1853.	Deaths by Cho- lera to 100,000 living.	Water Supply.
Bermondsey . . .	48,128	73	150	Southwark & Vauxhall.
S. Saviour, South- wark . . . }	35,731	52	146	{ Southwark and Vaux- hall, Lambeth.
S. George, South- wark . . . }	51,824	74	143	{ Southwark and Vaux- hall, Lambeth.
St. Olave . . .	19,375	26	134	Southwark & Vauxhall.
Rotherhithe . . .	17,805	20	112	South. & Vaux., Kent.
Whitechapel . . .	79,759	78	95	East London.
Newington . . .	64,816	37	57	{ Southwark and Vaux- hall, Lambeth.
Kensington,—ex- cept Paddington }	73,699	40	53	{ West Middlesex, Chel- sea, Grand Junction.
Wandsworth . . .	50,764	26	51	{ South. & Vaux., Pump wells, River Wandle.
St. George (East)	48,376	21	43	East London.
Camberwell . . .	54,667	22	40	{ Southwark and Vaux- hall, Lambeth.
Stepney . . .	110,775	40	34	East London.
Lambeth . . .	139,325	48	34	Lambeth, Sou. & Vaux.
Greenwich . . .	99,365	32	31	Kent.
Marylebone . . .	157,696	48	30	West Middlesex.
Westminster . . .	65,609	19	27	Chelsea.
St. James, West- minster . . . }	36,406	9	25	{ Grand Junction, New River.
Hackney . . .	58,429	13	22	New Riv., East London.
Paddington . . .	46,305	10	22	Grand Junction.
Shoreditch . . .	109,257	23	21	New Riv., East London.
Bethnal Green . . .	90,193	18	20	East London.
Poplar . . .	47,162	9	17	East London.
West London . . .	28,840	4	14	New River.
Hanover Square } and May Fair . }	33,196	5	12	Grand Junction.
Islington . . .	95,329	12	12	New River.
Chelsea . . .	56,538	6	11	Chelsea.
East London . . .	44,406	4	9	New River.
London City . . .	55,932	5	9	New River.
Clerkenwell . . .	64,778	5	8	New River.
Belgrave . . .	40,034	3	7	Chelsea.
St. Martin-in-the- Fields . . . }	24,640	1	5	New River.
St. Pancras . . .	166,956	8	5	{ New River, Hampstead, West Middlesex.
St. Luke . . .	54,055	2	4	New River.
Lewisham . . .	34,835	1	3	Kent.
Holborn . . .	46,571	1	2	New River.
St. Giles . . .	54,214	1	2	New River.
Strand . . .	44,460	—	—	New River.
Hampstead . . .	11,986	—	—	Hampst., West Midsex.
	2,362,236	796	—	

It will be observed that Lambeth, which is supplied with water in a great measure by the Lambeth Company, occupies a lower position in the above table than it did in the previous table showing the mortality in 1849. Rotherhithe also has been removed from the first to the fifth place; owing, no doubt, to the portion of the district supplied with water from the Kent Water Works, instead of the ditches, being altogether free from the disease, as was noticed above.

As the Registrar-General published a list of all the deaths from cholera which occurred in London in 1853, from the commencement of the epidemic in August to its conclusion in January 1854, I have been able to add up the number which occurred in the various sub-districts on the south side of the Thames, to which the water supply of the Southwark and Vauxhall, and the Lambeth Companies, extends. I have presented them in the table opposite, arranged in three groups.

Besides the general result shown in the table, there are some particular facts well worthy of consideration. In 1849, when the water of the Lambeth Company was quite as impure as that of the Southwark and Vauxhall Company, the parish of Christchurch suffered a rather higher rate of mortality from cholera than the adjoining parish of St. Saviour; but in 1853, whilst the mortality in St. Saviour's was at the rate of two hundred and twenty-seven to one hundred thousand living, that of Christchurch was only at the rate of forty-three. Now St. Saviour's is supplied with water entirely by the Southwark and Vauxhall Company, and Christchurch is chiefly supplied by the Lambeth Company. The pipes and other property of the Lambeth Company, in the parish of Christchurch, are rated at about £316, whilst the property of the Southwark and Vauxhall Company in this

TABLE VI.

Sub-Districts.	Popula- tion in 1851.	Deaths from Cholera in 1853.	Deaths by Cho- lera in each 100,000 living.	Water Supply.
St. Saviour, Southwark	19,709	45	227	Southwark and Vauxhall Water Company only.
St. Olave	8,015	19	237	
St. John, Horsleydown	11,360	7	61	
St. James, Bermondsey	18,899	21	111	
St. Mary Magdalen . .	13,934	27	193	
Leather Market . . .	15,295	23	153	
Rotherhithe*	17,805	20	112	
Wandsworth	9,611	3	31	
Battersea	10,560	11	104	
Putney	5,280	—	—	
Camberwell	17,742	9	50	
Peckham	19,444	7	36	
Christchurch, Southwk.	16,022	7	43	Lambeth Water Company, and Southwark and Vauxhall Com- pany.
Kent Road	18,126	37	204	
Borough Road	15,862	26	163	
London Road	17,836	9	50	
Trinity, Newington . .	20,922	11	52	
St. Peter, Walworth . .	29,861	23	77	
St. Mary, Newington . .	14,033	5	35	
Waterloo (1st part) . .	14,088	1	7	
Waterloo (2nd part) . .	18,348	7	38	
Lambeth Church (1st part)	18,409	9	48	
Lambeth Church (2nd part)	26,784	11	41	
Kennington (1st part)	24,261	12	49	
Kennington (2nd part)	18,848	6	31	
Brixton	14,610	2	13	
Clapham	16,290	10	61	
St. George, Camberwell	15,849	6	37	
Norwood	3,977	—	—	Lambeth Water Company only.
Streatham	9,023	—	—	
Dulwich	1,632	—	—	
First 12 sub-districts .	167,654	192	114	Southwk. & Vaux.
Next 16 sub-districts .	301,149	182	60	Both Companies.
Last 3 sub-districts . .	14,632	—	—	Lambeth Comp.

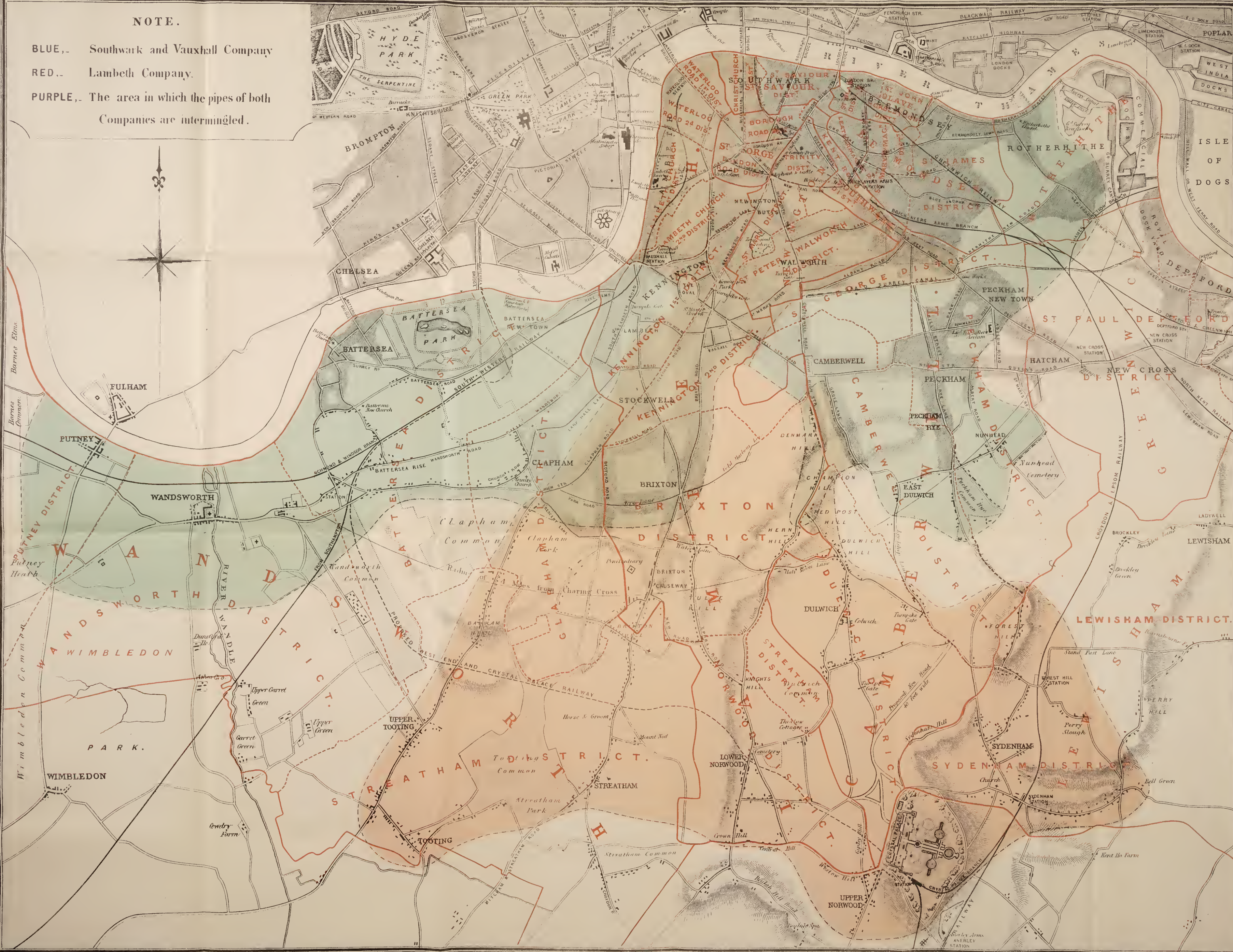
* A part of Rotherhithe was supplied by the Kent Water Company ;
but there was no cholera in this part.

parish is only rated at about £108. Waterloo Road, 1st part, suffered almost as much as St. Saviour's in 1849, and had but a single death in 1853; it is supplied almost exclusively by the Lambeth Company. The sub-districts of Kent Road and Borough Road, which suffered severely from cholera, are supplied, through a great part of their extent, exclusively by the Southwark and Vauxhall Company; the supply of the Lambeth Company being intermingled with that of the other only in a part of these districts, as may be seen by consulting the accompanying map (No. 2). The rural districts of Wandsworth and Peckham contain a number of pump-wells, and are only partially supplied by the Water Company; on this account they suffered a lower mortality than the other sub-districts supplied with the water from Battersea Fields. In the three sub-districts to which this water does not extend, there was no death from cholera in 1853.

Although the facts shown in the above table afford very strong evidence of the powerful influence which the drinking of water containing the sewage of a town exerts over the spread of cholera, when that disease is present, yet the question does not end here; for the intermixing of the water supply of the Southwark and Vauxhall Company with that of the Lambeth Company, over an extensive part of London, admitted of the subject being sifted in such a way as to yield the most incontrovertible proof on one side or the other. In the sub-districts enumerated in the above table as being supplied by both Companies, the mixing of the supply is of the most intimate kind. The pipes of each Company go down all the streets, and into nearly all the courts and alleys. A few houses are supplied by one Company and a few by the other, according to the decision of the owner or occupier at that time

NOTE.

- BLUE,-- Southwark and Vauxhall Company
- RED,-- Lambeth Company.
- PURPLE,-- The area in which the pipes of both Companies are intermingled.



when the Water Companies were in active competition. In many cases a single house has a supply different from that on either side. Each company supplies both rich and poor, both large houses and small ; there is no difference either in the condition or occupation of the persons receiving the water of the different Companies. Now it must be evident that, if the diminution of cholera, in the districts partly supplied with the improved water, depended on this supply, the houses receiving it would be the houses enjoying the whole benefit of the diminution of the malady, whilst the houses supplied with the water from Battersea Fields would suffer the same mortality as they would if the improved supply did not exist at all. As there is no difference whatever, either in the houses or the people receiving the supply of the two Water Companies, or in any of the physical conditions with which they are surrounded, it is obvious that no experiment could have been devised which would more thoroughly test the effect of water supply on the progress of cholera than this, which circumstances placed ready made before the observer.

The experiment, too, was on the grandest scale. No fewer than three hundred thousand people of both sexes, of every age and occupation, and of every rank and station, from gentlefolks down to the very poor, were divided into two groups without their choice, and, in most cases, without their knowledge ; one group being supplied with water containing the sewage of London, and, amongst it, whatever might have come from the cholera patients, the other group having water quite free from such impurity.

To turn this grand experiment to account, all that was required was to learn the supply of water to each individual house where a fatal attack of cholera might occur. I regret that, in the short days at the latter part of last

year, I could not spare the time to make the inquiry ; and, indeed, I was not fully aware, at that time, of the very intimate mixture of the supply of the two Water Companies, and the consequently important nature of the desired inquiry.

When the cholera returned to London in July of the present year, however, I resolved to spare no exertion which might be necessary to ascertain the exact effect of the water supply on the progress of the epidemic, in the places where all the circumstances were so happily adapted for the inquiry. I was desirous of making the investigation myself, in order that I might have the most satisfactory proof of the truth or fallacy of the doctrine which I had been advocating for five years. I had no reason to doubt the correctness of the conclusions I had drawn from the great number of facts already in my possession, but I felt that the circumstance of the cholera-poison passing down the sewers into a great river, and being distributed through miles of pipes, and yet producing its specific effects, was a fact of so startling a nature, and of so vast importance to the community, that it could not be too rigidly examined, or established on too firm a basis.

I accordingly asked permission at the General Register Office to be supplied with the addresses of persons dying of cholera, in those districts where the supply of the two Companies is intermingled in the manner I have stated above. Some of these addresses were published in the "Weekly Returns," and I was kindly permitted to take a copy of others. I commenced my inquiry about the middle of August with two sub-districts of Lambeth, called Kennington, first part, and Kennington, second part. There were forty-four deaths in these sub-districts down to 12th August, and I found that thirty-eight of the houses in which these deaths occurred were supplied with

water by the Southwark and Vauxhall Company, four houses were supplied by the Lambeth Company, and two had pump-wells on the premises and no supply from either of the Companies.

As soon as I had ascertained these particulars I communicated them to Dr. Farr, who was much struck with the result, and at his suggestion the Registrars of all the south districts of London were requested to make a return of the water supply of the house in which the attack took place, in all cases of death from cholera. This order was to take place after the 26th August, and I resolved to carry my inquiry down to that date, so that the facts might be ascertained for the whole course of the epidemic. I pursued my inquiry over the various other sub-districts of Lambeth, Southwark, and Newington, where the supply of the two Water Companies is intermixed, with a result very similar to that already given, as will be seen further on. In cases where persons had been removed to a work-house or any other place, after the attack of cholera had commenced, I inquired the water supply of the house where the individuals were living when the attack took place.

The inquiry was necessarily attended with a good deal of trouble. There were very few instances in which I could at once get the information I required. Even when the water-rates are paid by the residents, they can seldom remember the name of the Water Company till they have looked for the receipt. In the case of working people who pay weekly rents, the rates are invariably paid by the landlord or his agent, who often lives at a distance, and the residents know nothing about the matter. It would, indeed, have been almost impossible for me to complete the inquiry, if I had not found that I could distinguish the water of the two companies with perfect

certainly by a chemical test. The test I employed was founded on the great difference in the quantity of chloride of sodium contained in the two kinds of water, at the time I made the inquiry. On adding solution of nitrate of silver to a gallon of the water of the Lambeth Company, obtained at Thames Ditton, beyond the reach of the sewage of London, only 2·28 grains of chloride of silver were obtained, indicating the presence of ·95 grains of chloride of sodium in the water. On treating the water of the Southwark and Vauxhall Company in the same manner, 91 grains of chloride of silver were obtained, showing the presence of 37·9 grains of common salt per gallon. Indeed, the difference in appearance on adding nitrate of silver to the two kinds of water was so great, that they could be at once distinguished without any further trouble. Therefore when the resident could not give clear and conclusive evidence about the Water Company, I obtained some of the water in a small phial, and wrote the address on the cover, when I could examine it after coming home. The mere appearance of the water generally afforded a very good indication of its source, especially if it was observed as it came in, before it had entered the water-butt or cistern; and the time of its coming in also afforded some evidence of the kind of water, after I had ascertained the hours when the turncocks of both Companies visited any street. These points were, however, not relied on, except as corroborating more decisive proof, such as the chemical test, or the Company's receipt for the rates.

A return had been made to Parliament of the entire number of houses supplied with water by each of the Water Companies, but as the number of houses which they supplied in particular districts was not stated, I found that it would be necessary to carry my inquiry into

all the districts to which the supply of either Company extends, in order to show the full bearing of the facts brought out in those districts where the supply is intermingled. I inquired myself respecting every death from cholera in the districts to which the supply of the Lambeth Company extends, and I was fortunate enough to obtain the assistance of a medical man, Mr. John Joseph Whiting, L.A.C., to make inquiry in Bermondsey, Rotherhithe, Wandsworth, and certain other districts, which are supplied only by the Southwark and Vauxhall Company. Mr. Whiting took great pains with his part of the inquiry, which was to ascertain whether the houses in which the fatal attacks took place were supplied with the Company's water, or from a pump-well, or some other source.

Mr. Whiting's part of the investigation extended over the first four weeks of the epidemic, from 8th July to 5th August ; and as inquiry was made respecting every death from cholera during this part of the epidemic, in all the districts to which the supply of either of the Water Companies extends, it may be well to consider this period first. There were three hundred and thirty-four deaths from cholera in these four weeks, in the districts to which the water supply of the Southwark and Vauxhall and the Lambeth Company extends. Of these it was ascertained, that in two hundred and eighty-six cases the house where the fatal attack of cholera took place was supplied with water by the Southwark and Vauxhall Company, and in only fourteen cases was the house supplied with the Lambeth Company's water ; in twenty-two cases the water was obtained by dipping a pail directly into the Thames, in four instances it was obtained from pump-wells, in four instances from ditches, and in four cases the source of supply was not ascertained, owing to the person being

taken ill whilst travelling, or from some similar cause. The particulars of all the deaths which were caused by cholera in the first four weeks of the late epidemic, were published by the Registrar-General in the "Weekly Returns of Births and Deaths in London," and I have had the three hundred and thirty-four above enumerated reprinted in an appendix to this edition, as a guarantee that the water supply was inquired into, and to afford any person who wishes it an opportunity of verifying the result. Any one who should make the inquiry must be careful to find the house where the attack took place, for in many streets there are several houses having the same number.

According to a return which was made to Parliament, the Southwark and Vauxhall Company supplied 40,046 houses from January 1st to December 31st, 1853, and the Lambeth Company supplied 26,107 houses during the same period ; consequently, as 286 fatal attacks of cholera took place, in the first four weeks of the epidemic, in houses supplied by the former Company, and only 14 in houses supplied by the latter, the proportion of fatal attacks to each 10,000 houses was as follows. Southwark and Vauxhall 71. Lambeth 5. The cholera was therefore fourteen times as fatal at this period, amongst persons having the impure water of the Southwark and Vauxhall Company, as amongst those having the purer water from Thames Ditton.

It is extremely worthy of remark, that whilst only five hundred and sixty-three deaths from cholera occurred in the whole of the metropolis, in the four weeks ending 5th August, more than one half of them took place amongst the customers of the Southwark and Vauxhall Company, and a great portion of the remaining deaths were those of mariners and persons employed amongst the shipping in

the Thames, who almost invariably draw their drinking water direct from the river.

It may, indeed, be confidently asserted, that if the Southwark and Vauxhall Water Company had been able to use the same expedition as the Lambeth Company in completing their new works, and obtaining water free from the contents of sewers, the late epidemic of cholera would have been confined in a great measure to persons employed among the shipping, and to poor people who get water by pailsful direct from the Thames or tidal ditches.

The number of houses in London at the time of the last census was 327,391. If the houses supplied with water by the Southwark and Vauxhall Company, and the deaths from cholera occurring in these houses, be deducted, we shall have in the remainder of London 287,345 houses, in which 277 deaths from cholera took place in the first four weeks of the epidemic. This is at the rate of nine deaths to each 10,000. But the houses supplied with water by the Lambeth Company only suffered a mortality of five in each 10,000 at this period ; it follows, therefore, that these houses, although intimately mixed with those of the Southwark and Vauxhall Company, in which so great a proportional mortality occurred, did not suffer even so much as the rest of London which was not so situated.

In the beginning of the late epidemic of cholera in London, the Thames water seems to have been the great means of its diffusion, either through the pipes of the Southwark and Vauxhall Company, or more directly by dipping a pail in the river. Cholera was prevailing in the Baltic Fleet in the early part of summer, and the following passage from the "Weekly Returns" of the Registrar-General shows that the disease was probably imported thence to the Thames.

“ Bermondsey, St. James. At 10, Marine Street, on 25th July, a mate mariner, aged 34 years, Asiatic cholera 101 hours, after premonitory diarrhœa $16\frac{1}{2}$ hours. The medical attendant states : ‘ This patient was the chief mate to a steam-vessel taking stores to and bringing home invalids from the Baltic Fleet. Three weeks ago he brought home in his cabin the soiled linen of an officer who had been ill. The linen was washed and returned.’ ”

The time when this steam-vessel arrived in the Thames with the soiled linen on board, was a few days before the first cases of cholera appeared in London, and these first cases were chiefly amongst persons connected with the shipping in the river. It is not improbable therefore that a few simple precautions, with respect to the communications with the Baltic Fleet, might have saved London from the cholera this year, or at all events greatly retarded its appearance.

As the epidemic advanced, the disproportion between the number of cases in houses supplied by the Southwark and Vauxhall Company and those supplied by the Lambeth Company, became not quite so great, although it continued very striking. In the beginning of the epidemic the cases appear to have been almost altogether produced through the agency of the Thames water obtained amongst the sewers ; and the small number of cases occurring in houses not so supplied, might be accounted for by the fact of persons not keeping always at home and taking all their meals in the houses in which they live ; but as the epidemic advanced it would necessarily spread amongst the customers of the Lambeth Company, as in parts of London where the water was not in fault, by all the usual means of its communication. The two subjoined tables, VII and VIII, show the number of fatal attacks in houses supplied respectively by the two Companies, in all

the sub-districts to which their water extends. The cases in table VII, are again included in the larger number which appear in the next table. The sub-districts are arranged in three groups, as they were in table VI, illustrating the epidemic of 1853.

In table VIII, showing the mortality in the first seven weeks of the epidemic, the water supply is the result of my own personal inquiry, in every case, in all the sub-districts to which the supply of the Lambeth Company extends; but in some of the sub-districts supplied only by the Southwark and Vauxhall Company, the inquiry of Mr. Whiting having extended only to 5th August, the water supply of the last three weeks is calculated to have been in the same proportion by the Company, or by pump wells, etc., as in the first four weeks,—a calculation which is perfectly fair, and must be very near the truth. The sub-districts in which the supply is partly founded on computation, are marked with an asterisk.

The numbers in table VIII differ a very little from those of the table I communicated to the *Medical Times and Gazette* of 7th October, on account of the water supply having since been ascertained in some cases in which I did not then know it. The small number of instances in which the water supply remains unascertained are chiefly those of persons taken into a workhouse without their address being known.

TABLE VII.

The mortality from Cholera in the four weeks
ending 5th August.

Sub-Districts.	Popula- tion in 1851.	Deaths from Cholera in the four wks. end- ing 5th August.	Water Supply.				
			Southwark & Vauxhall.	Lambeth.	Pump-wells.	River Thames, ditches, etc.	Unascertained.
St. Saviour, Southwark	19,709	26	24	—	—	2	—
St. Olave, Southwark .	8,015	19	15	—	—	2	2
St. John, Horsleydown	11,360	18	17	—	—	1	—
St. James, Bermondsey	18,899	29	23	—	—	6	—
St. Mary Magdalen .	13,934	20	19	—	—	1	—
Leather Market .	15,295	23	23	—	—	—	—
Rotherhithe . .	17,805	26	17	—	—	9	—
Battersea . . .	10,560	13	10	—	1	2	—
Wandsworth . . .	9,611	2	—	—	—	2	—
Putney	5,280	1	—	—	1	—	—
Camberwell . . .	17,742	19	19	—	—	—	—
Peckham	19,444	4	4	—	—	—	—
Christchurch, Southwk.	16,022	3	2	1	—	—	—
Kent Road . . .	18,126	8	7	1	—	—	—
Borough Road . .	15,862	21	20	1	—	—	—
London Road . . .	17,836	9	5	4	—	—	—
Trinity, Newington .	20,922	14	14	—	—	—	—
St. Peter, Walworth .	29,861	20	20	—	—	—	—
St. Mary, Newington .	14,033	5	5	—	—	—	—
Waterloo Road (1st) .	14,088	5	5	—	—	—	—
Waterloo Road (2nd) .	18,348	5	5	—	—	—	—
Lambeth Church (1st)	18,409	5	2	1	—	1	1
Lambeth Church (2nd)	26,784	10	7	2	—	—	1
Kennington (1st) . .	24,261	11	9	1	1	—	—
Kennington (2nd) . .	18,848	3	3	—	—	—	—
Brixton	14,610	1	—	1	—	—	—
Clapham	16,290	5	4	—	1	—	—
St. George, Camberwell	15,849	9	7	2	—	—	—
Norwood	3,977	—	—	—	—	—	—
Streatham	9,023	—	—	—	—	—	—
Dulwich	1,632	—	—	—	—	—	—
Sydenham	4,501	—	—	—	—	—	—
	486,936	334	286	14	4	26	4

TABLE VIII.

Mortality from Cholera in the seven weeks
ending 26th August.

Sub-Districts.	Popula- tion in 1851.	Deaths from Cholera in the seven weeks ending 26th August.	Water Supply.				
			Southwark & Vauxhall.	Lambeth.	Pump-wells.	River Thames and ditches.	Unascertained.
*St.Saviour, Southwark	19,709	125	115	—	—	10	—
*St. Olave, Southwark	8,015	53	43	—	—	5	5
*St. John, Horsleydown	11,360	51	48	—	—	3	—
*St. James, Bermondsey	18,899	123	102	—	—	21	—
*St. Mary Magdalen .	13,934	87	83	—	—	4	—
*Leather Market .	15,295	81	81	—	—	—	—
*Rotherhithe . .	17,805	103	68	—	—	35	—
*Battersea . . .	10,560	54	42	—	4	8	—
Wandsworth . . .	9,611	11	1	—	2	8	—
Putney	5,280	1	—	—	1	—	—
*Camberwell . . .	17,742	96	96	—	—	—	—
*Peckham	19,444	59	59	—	—	—	—
Christchurch, Southwk.	16,022	25	11	13	—	—	1
Kent Road . . .	18,126	57	52	5	—	—	—
Borough Road . .	15,862	71	61	7	—	—	3
London Road . . .	17,836	29	21	8	—	—	—
Trinity, Newington .	20,922	58	52	6	—	—	—
St. Peter, Walworth .	29,861	90	84	4	—	—	2
St. Mary, Newington.	14,033	21	19	1	1	—	—
Waterloo Road (1st) .	14,088	10	9	1	—	—	—
Waterloo Road (2nd)	18,348	36	25	8	1	2	—
Lambeth Church (1st)	18,409	18	6	9	—	1	2
Lambeth Church (2nd)	26,748	53	34	13	1	—	5
Kennington (1st) . .	24,261	71	63	5	3	—	—
Kennington (2nd) . .	18,848	38	34	3	1	—	—
Brixton	14,610	9	5	2	—	—	2
*Clapham	16,290	24	19	—	5	—	—
St. George, Camberwell	15,849	42	30	9	2	—	1
Norwood	3,977	8	—	2	1	5	—
Streatham	9,023	6	—	1	5	—	—
Dulwich	1,632	—	—	—	—	—	—
Sydenham	4,501	4	—	1	2	—	1
	486,936	1514	1263	98	29	102	22

The following is the proportion of deaths to 10,000 houses, during the first seven weeks of the epidemic, in the population supplied by the Southwark and Vauxhall Company, in that supplied by the Lambeth Company, and in the rest of London.

TABLE IX.

	Number of houses.	Deaths from Cholera.	Deaths in each 10,000 houses.
Southwark and Vauxhall Company	40,046	1,263	315
Lambeth Company	26,107	98	37
Rest of London	256,423	1,422	59

The mortality in the houses supplied by the Southwark and Vauxhall Company was therefore between eight and nine times as great as in the houses supplied by the Lambeth Company; and it will be remarked that the customers of the Lambeth Company continued to enjoy an immunity from cholera greater than the rest of London which is not mixed up as they are with the houses supplied by the Southwark and Vauxhall Company.

As regards the period of the epidemic subsequent to the 26th August to which my inquiry extended, I have stated that the Registrar General requested the District Registrars to make a return of the water supply of the house of attack in all cases of death from cholera. Owing to difficulties such as I explained that I had met with in the beginning of my inquiry, the Registrars could not ~~make~~ make the return in all cases, and as they could not be expected to seek out the landlord or his agent, or to apply chemical tests to the water as I had done, the water supply remained unascertained in a number of cases, but

the numbers may undoubtedly be considered to show the correct proportions as far as they extend, and they agree entirely with the results of my inquiry respecting the earlier part of the epidemic given above.

The Registrar General published the returns of the water supply, which he had obtained from the District Registrars, down to 14th October, in a table which is subjoined. As the whole of the south districts of London were included in the inquiry of the Registrar General, the deaths in the Greenwich and Lewisham districts, which are supplied by the Kent Water Company, and did not enter into my inquiry, are included in the table, but they do not in the least affect the numbers connected with the other companies.

TABLE X.

Week ending	Deaths from Cholera.	Water Supply.				
		Southwk. and Vauxhall.	Lambeth.	Kent Company.	Pumps, and other sources.	Not ascertained.
September 2.	670	399	45	38	72	116
„ 9.	972	580	72	45	62	213
„ 16.	856	524	66	48	44	174
„ 23.	724	432	72	28	62	130
„ 30.	383	228	25	19	24	87
October 7.	200	121	14	10	9	46
„ 14.	115	69	8	3	6	29
	3920	2353	302	191	279	795

Now 2,353 deaths in 40,046 houses, the number supplied by the Southwark and Vauxhall Company, are 573 deaths to each 10,000 houses ; and 302 deaths to 26,107, the number of houses supplied by the Lambeth Company, are 115 deaths to each 10,000 houses ; consequently, in

the second seven weeks of the epidemic, the population supplied by the Southwark and Vauxhall Company continued to suffer nearly five times the mortality of that supplied with water by the Lambeth Company. If the 795 deaths in which the water supply was not ascertained be distributed equally over the other sources of supply in the above table (No. x), the deaths in houses supplied by the Southwark and Vauxhall Company would be 2,830, and in houses supplied by the Lambeth Company would be 363. By adding the number of deaths which occurred in the first seven weeks of the epidemic, we get the numbers in the subjoined table (No. xi), where the population of the houses supplied by the two water companies is that estimated by the Registrar General.*

TABLE XI.

	Population in 1851.	Deaths by Cholera in 14 wks. end- ing Oct. 14.	Deaths in 10,000 living.
London	2,362,236	10,367	43
West Districts	376,427	1,992	53
North Districts	490,396	735	14
Central Districts	393,256	612	15
East Districts	485,522	1,461	30
South Districts	616,635	5,567	90
Houses supplied by Southwark and Vauxhall Company	266,516	4,093	153
Houses supplied by Lambeth Com- pany	173,748	461	26

We see by the above table that the houses supplied with the water from Thames Ditton, by the Lambeth

* Weekly Return, Oct. 14, p. 433.

Company, continued throughout the epidemic to enjoy an immunity from cholera, not only greater than London at large, but greater than every group of districts, except the north and central groups.

In the next table (No. XII), the mortality from cholera in 1849 is shown side by side with that of 1854, in the various sub-districts to which the supply of the two water companies with which we are particularly interested extends. The mortality of 1854 is down to October 21, and is extracted from a table published in the "Weekly Return of Births and Deaths" of October 28; that of 1849 is from the "Report on Cholera" by Dr. Farr, previously quoted. The sub-districts are arranged in three groups as before, the first group being supplied only by the Southwark and Vauxhall Company, the second group by this Company and the Lambeth, and the third group by the Lambeth Company only. It is necessary to observe, however, that the supply of the Lambeth Company has been extended to Streatham, Norwood, and Sydenham, since 1849, in which year these places were not supplied by any water company. The situation and extent of the various sub-districts are shown, together with the nature of the water supply, in Map 2, which accompanies this work.

The table exhibits an increase of mortality in 1854 as compared with 1849, in the sub-districts supplied by the Southwark and Vauxhall Company only, whilst there is a considerable diminution of mortality in the sub-districts partly supplied by the Lambeth Company. In certain sub-districts, where I know that the supply of the Lambeth Water Company is more general than elsewhere, as Christchurch, London Road, Waterloo Road 1st, and Lambeth Church 1st, the decrease of mortality in 1854 as compared with 1849 is greatest, as might be expected.

TABLE XII.

Sub-Districts.	Deaths from Cholera in 1849.	Deaths from Cholera in 1854.	Water Supply.
St. Saviour, Southwark .	283	371	Southwark & Vaux- hall Company only.
St. Olave	157	161	
St. John, Horsleydown .	192	148	
St. James, Bermondsey .	249	362	
St. Mary Magdalen .	259	244	
Leather Market . . .	226	237	
Rotherhithe* . . .	352	282	
Wandsworth	97	59	
Battersea	111	171	
Putney	8	9	
Camberwell	235	240	
Peckham	92	174	
Christchurch, Southwark	256	113	Lambeth Company, and Southwark and Vauxhall Compy.
Kent Road	267	174	
Borough Road	312	270	
London Road	257	93	
Trinity, Newington .	318	210	
St. Peter, Walworth .	446	388	
St. Mary, Newington .	143	92	
Waterloo Road (1st) .	193	58	
Waterloo Road (2nd) .	243	117	
Lambeth Church (1st) .	215	49	
Lambeth Church (2nd) .	544	193	
Kennington (1st) . . .	187	303	
Kennington (2nd) . . .	153	142	
Brixton	81	48	
Clapham	114	165	
St. George, Camberwell	176	132	
Norwood	2	10	Lambeth Company only.
Streatham	154	15	
Dulwich	1	—	
Sydenham	5	12	
First 12 sub-districts .	2261	2458	Southwk. & Vauxhall.
Next 16 sub-districts .	3905	2547	Both Companies.
Last 4 sub-districts .	162	37	Lambeth Company.

* A small part of Rotherhithe is now supplied by the Kent Water Company.

Waterloo Road 1st, which suffered but little from cholera in the present year, is chiefly composed of very dirty narrow streets, in the neighbourhood of Cornwall Road and the New Cut, inhabited by very poor people; and Lambeth Church 1st, which suffered still less, contains a number of skinyards and other factories, between Lambeth Palace and Vauxhall Bridge, which have often been inveighed against as promoting the cholera. The high mortality of the Streatham district in 1849 was caused by the outbreak of cholera in Drouett's Asylum for pauper children, previously mentioned.

Whilst making inquiries in the south districts of London, I learned some circumstances with respect to the workhouses which deserve to be noticed. In Newington Workhouse, containing 650 inmates, and supplied with the water from Thames Ditton, there had been but two deaths from cholera amongst the inmates down to 21st September, when the epidemic had already greatly declined. In Lambeth Workhouse, containing, if I remember rightly, nearly 1,000 inmates, and supplied with the same water, there had been but one death amongst the inmates when I was there in the first week of September. In St. Saviour's workhouse, which is situated in the parish of Christchurch, and is supplied with water by the Lambeth Company, no inmate died of cholera before I called in the first week of September. On the other hand, in the workhouse of St. George, Southwark, supplied with the water of the Southwark and Vauxhall Company, six inmates died out of about 600 before the 26th August, when the epidemic had only run one-third of its course. The mortality was also high amongst the inmates of St. Olave's Workhouse, supplied with water by the Southwark and Vauxhall Company, but I do not know the number who died. I trust, however, that the Registrar

General, in giving an account of the recent epidemic, will make a return of the deaths amongst the inmates of the various workhouses and other institutions on the south side of the Thames, together with the water supply of the buildings. Bethlehem Hospital, the Queen's Prison, Horsemonger Lane Gaol, and some other institutions, having deep wells on the premises, scarcely suffered at all from cholera in 1849, and there was no death in any of them during the part of the recent epidemic to which my inquiry extended.

On the north side of the Thames the mortality during the recent epidemic seems to have been influenced more by the relative crowding and want of cleanly habits of the people, and by the accidental contamination of the pump-wells, than by the supply of the water companies. The water of the New River Company could have no share in the propagation of cholera, as I explained when treating of the epidemic of 1849; and the extensive districts supplied by this company have been very slightly visited by the disease, except in certain spots which were influenced by the causes above mentioned. | The water of the East London Company is also free from the contents of sewers, unless it be those from the neighbourhood of Upper Clapton, where there has been very little cholera. The districts supplied by this company have been lightly visited, except such as lie near the Thames, and are inhabited by mariners, coal and ballast-heavers, and others, who are employed on the river. Even Bethnal Green and Spitalfields, so notorious for their poverty and squalor, have suffered a mortality much below the average of the metropolis. The Grand Junction Company obtain their supply at Brentford, within the reach of the tide and near a large population, but they detain the water in large reservoirs, and their officers tell me they filter it; at all

events, they supply it in as pure a state as that of the Lambeth Company obtained at Thames Ditton, and their districts have suffered very little from cholera except at the spot where the irruption occurred from the contamination of the pump-well in Broad Street, Golden Square. The West Middlesex Company, obtaining their supply from the Thames at Hammersmith, have also very large reservoirs, and the districts they supply have suffered but little from cholera, except the Kensington brick fields, Starch Green, and certain other spots, crowded with poor people, chiefly Irish.

The districts supplied by the Chelsea Company have suffered a much greater mortality, during the recent epidemic, than the average of the whole metropolis, as the subjoined table (No. XIII) shows. But the mortality in these districts is only half as great as in the houses supplied by the Southwark and Vauxhall Company, who obtain their supply from the Thames just opposite the spot where the Chelsea Company obtain theirs. The latter company, however, by detaining the water in their reservoirs, and by filtering it, are enabled to distribute it in a state of comparative purity ; but I had ample opportunities of observing, in August and September last, that this was far from being the state of the water supplied by the Southwark and Vauxhall Company. Many of the people receiving this latter supply were in the habit of tying a piece of linen or some other fabric over the tap by which the water entered the butt or cistern, and in two hours, as the water came in, about a tablespoon of dirt was collected, all in motion with a variety of water insects, whilst the strained water was far from being clear. The contents of the strainer were shown to me in scores of instances. I do not, of course, attribute the cholera either to the insects or the visible dirt ; but it is extremely probable that the measures adopted by the Chelsea Company

to free the water from these repulsive ingredients, either separated or caused the destruction of the morbid matter of cholera. It is very likely that the detention of the water in the company's reservoirs permitted the decomposition of the cholera poison, and was more beneficial than the filtering, for the following reasons. The water used in Millbank Prison, obtained from the Thames at Millbank, was filtered through sand and charcoal till it looked as clear as that of the Chelsea Company; yet, in every epidemic, the inmates of this prison suffered much more from cholera than the inhabitants of the neighbouring streets and those of Tothill Fields Prison, supplied by that company.* In the early part of August last, the use

TABLE XIII.

	Population in 1851.	Deaths by Cholera	
		In 15 wks. ending October 21.	To every 10,000 living.
Chelsea, south	19,050	122	64
Chelsea, north-west	17,669	99	56
Chelsea, north-east	19,819	71	36
Belgrave	40,034	238	59
St. John, Westminster	34,295	173	50
St. Margaret, Westminster	31,314	238	76
Total of districts supplied by the Chelsea Water Company	162,181	941	56
Houses supplied by the Southwark and Vauxhall Company	266,516	2,900	108
LONDON	2,362,236	10,530	45
London, except the houses supplied by the Chelsea Company, and by the Southwark & Vauxhall Compy.	1,933,539	6,689	34

* In 1849, there were forty-eight deaths from cholera in Millbank prison, amounting to 4·3 per cent. of the average number of prisoners. In Tothill Fields prison there were thirteen deaths among eight hundred prisoners, or 1·6 per cent. The other prisons on the north side of the Thames are supplied either by the New River Company, or from pump-wells, and there was but one death from cholera in all of them; that death took place in Newgate.

of the Thames water was entirely discontinued in Millbank Prison, and water from the Artesian well in Trafalgar Square was used instead, on the recommendation of Dr. Baly, the physician to the prison. In three or four days after this change, the cholera, which was prevailing to an alarming extent, entirely ceased.

The quantity of impurity in the Thames was greatly increased during the late autumn, by the long course of dry weather. From 5th August to 12th September, a period of more than five weeks, only 0·29 of an inch of rain fell at Greenwich, as appears by the report of the Astronomer Royal. The stream of the Thames above the reach of the tide became so slender, that it was difficult to navigate barges above Richmond. The Thames in London is a very large body of water, and if the whole of it flowed away into the sea every day, the liquid which flows down the sewers in twelve hours would form but a very small part of it ; but it must be remembered that the quantity of water which passes out to sea, with the ebb of every tide, is only equal to that which flows over Teddington Lock, and from a few small tributary streams. In hot dry weather this quantity is moreover greatly diminished by the evaporation taking place from the immense surface of water exposed between Richmond and Gravesend, so that the river becomes a kind of prolonged lake, the same water passing twice a day to and fro through London, and receiving the excrement of its two millions and more of inhabitants, which keeps accumulating till there is a fall of rain. In time of cholera, the evacuations of the patients keep accumulating in the river along with the other impurities ; and it is probably in this way that the dry weather with a high barometer aids in promoting cholera, as it has often been observed to do.

I thought at first that the quantity of common salt, pre-

viously mentioned as being present in the water of the Southwark and Vauxhall Company, consisted entirely of the salt which had passed down the sewers into the river, for I had no idea that any admixture of sea water reached as high as Battersea Fields. Mr. Quick, the engineer of the above Company, informed me, however, that an impregnation of salt water does extend as far after a long course of dry weather. It is obvious that a dry season, whilst it increases the quantity of impurity in the Thames, must also cause the sea water to flow further inland than at other times. I did not examine the water of the Thames in August or September, but I have done so now, at the latter part of November, and I am inclined to think that even yet a slight admixture of sea water may reach to Battersea Fields with every tide. I found 5·8 grains of chloride of sodium per gallon in water obtained at Hungerford Market, at half-flow of the tide, on 19th November, and 19·1 grains per gallon, in water obtained at the same place, on 27th November, at an hour and a half before high water; whilst water obtained at London Bridge, on 28th November, at high water, contained 63·3 grains per gallon.

A specimen of water obtained on 21st November, from a house supplied by the Southwark and Vauxhall Company, contained 28·8 grains of common salt per gallon, or about three-quarters as much as it contained in September, when the quantity was 37·9 grains. It is very obvious from the above analyses, that the Water Company obtain their supply from the Thames at high water, or nearly so, although this is the time of the tide when the water contains the greatest amount of impurity. It is quite certain that the sea water cannot reach to Thames Ditton, any more than the contents of the London sewers, and therefore, whatever may be its source, the

quantity of chloride of sodium in the water is quite conclusive as regards the purpose for which I examined into it, viz., to distinguish between the water of the two Companies.

When the water of the Southwark and Vauxhall Company was examined by Messrs. Graham, Miller, and Hofmann, at the latter part of January 1851, it contained only 1·99 grains of chloride of sodium, or about one-twentieth as much as it contained last September, and one-fifteenth as much as on 21st November 1854.*

Dr. Farr discovered a remarkable coincidence between the mortality from cholera in the different districts of London in 1849, and the elevation of the ground; the connection being of an inverse kind, the higher districts suffering least, and the lowest suffering most from this malady. Dr. Farr was inclined to think that the level of the soil had some direct influence over the prevalence of cholera, but the fact of the most elevated towns in this kingdom, as Wolverhampton, Dowlais, Merthyr Tydvil, and Newcastle-upon-Tyne, having suffered excessively from this disease on several occasions, is opposed to this view, as is also the circumstance of Bethlehem Hospital, the Queen's Prison, Horsemonger Lane Gaol, and several other large buildings, which are supplied with water from deep wells on the premises, having nearly or altogether escaped cholera, though situated on a very low level, and surrounded by the disease. The fact of Brixton, at an elevation fifty-six feet above Trinity high-water mark, having suffered a mortality of 55 in 10,000, whilst many districts on the north of the Thames, at less than half the

* Report by the Government Commission on the Chemical Quality of the Supply of Water to the Metropolis. (177.)

elevation, did not suffer one-third as much, also points to the same conclusion.

I expressed the opinion in 1849,* that the increased prevalence of cholera in the low-lying districts of London depended entirely on the greater contamination of the water in these districts, and the comparative immunity from this disease of the population receiving the improved water from Thames Ditton, during the epidemics of last year and the present, as shown in the previous pages, entirely confirms this view of the subject ; for the great bulk of this population live in the lowest districts of the metropolis.

The prevalence of cholera has been very much under the influence of the water supply in other towns besides London. The cholera has prevailed to a considerable extent in the crowded habitations of the poor in Liverpool and some other towns, where the general supply of water was not in fault, but I know of no instance in which it has spread through all classes of the community, except where the general supply of water has been contaminated with the contents of the drains and sewers ; and all the towns with which I am acquainted that have enjoyed an almost complete immunity from this disease, have a water supply quite free from any chance of contamination. Birmingham, Bath, Cheltenham, and Leicester have nearly escaped the cholera in every epidemic. The few cases that have occurred being chiefly those of persons newly arrived from places where the disease was prevailing, and a few others who came in communication with them. All these towns have a supply of water quite free from connection with the drains and sewers, and the small rivers which flow through them are so impure that it would be

* Medical Gazette, vol. xlv, p. 749.

impossible to drink the water. Leicester is crowded with a poor population, and has hardly any physical advantage except its water supply.

The first cases of cholera in Exeter in 1832, were three in the same day, besides one in St. Thomas's, a suburb of Exeter, in a gentleman just arrived from London, where the disease was prevailing. The other three were a woman and her two children; the former, with one of her children, had returned from Plymouth the previous day, where she had been nursing a child that had died of the cholera. Within five days from this time, there were seven fresh cases in as many different parts of the town, amongst persons having no intercourse with each other or the first cases. The disease soon became very prevalent, and in three months there were 1,135 cases, and 345 deaths. Exeter is situated on ground which rises from the edge of the river to an elevation of one hundred and fifty feet. In 1832 the inhabitants were chiefly supplied with river water by water-carriers, who conveyed it in carts and pails. Dr. Shapter, from whose work* the above particulars are obtained, kindly furnished me with information concerning the sewers, and with maps of their position. The water-carriers, by whom Exeter was very greatly supplied, obtained their water almost exclusively from certain streams of water, diverted from the river in order to turn water-mills; and one of the chief sewers of the town, which receives such sewage as might come from North Street, in which the first cases of cholera occurred, empties itself into the branch from the river which divides into the two mill-streams just mentioned. It must be remarked that the parish of St. Edmund, in which these streams of water were situated, had a lower mortality from cholera than other parts of the

* History of the Cholera in Exeter in 1832.

town like it, densely populated and on low ground near the river. Dr. Shapter attributes this lower rate of mortality, and I believe rightly, to St. Edmund's being freely intersected by running streams of water. The people would probably not drink more of the water than in parts of the town where it was less plentiful, and had to be paid for, but they would have much better opportunities for personal cleanliness: so that whilst they would be exposed to only the same number of scattered cases, they would be less likely to have the malady spreading through families, and by personal intercourse. After the cholera of 1832, measures were taken to afford a better supply of water to Exeter; not, so far as I can find by Dr. Shapter's work, that its impurity was complained of, but because of its scarcity and cost. Water-works were established on the river Exe, two miles above the town, and more than two miles above the influence of the tide. Exeter has since been very plentifully supplied with this water, and Dr. Shapter informed me that in 1849 there were only about twenty cases of cholera, nearly half of which occurred in strangers coming into the town, and dying within two or three days after their arrival. This last summer there was only one death from cholera in Exeter.

We will now consider the town of Hull, in which, together with other sanitary measures adopted since 1832, there has been a new and more plentiful supply of water, but with a far different result to that at Exeter. In 1832 Hull was scantily supplied with water conveyed in pipes from springs at Anlaby, three miles from the town. About 1844, new water-works were established to afford a more plentiful supply. These works were situated on the river Hull, at Stoneferry, two miles and three quarters from the confluence of that river with the Humber. About half the sewage of the town is delivered into the

river of the same name, the rest being discharged into the Humber, as appears from information and a map kindly furnished me in 1849 by Dr. Horner of Hull, who was making great efforts to have better water obtained for the town. The tide flows up the river many miles past the water-works, carrying up with it the filth from the sewers. The supply of water was, to be sure, obtained when the tide was down, but as the banks of the river are clothed with sedges in many parts, and its bottom deep with mud, the water can never be free from sewage. Moreover, there are some parts of the river above Stoneferry much deeper than the rest, and where the deeper water is, according to the testimony of boatmen, nearly stagnant ; thus allowing the water carried up by the tide to remain and gradually mix with that afterwards flowing down. There are also boats, with families on board, passing up the river to the extent of five thousand voyages in the year. The water when taken from the river was allowed to settle in the reservoir for twenty-four hours, and was then said to be filtered before being sent to the town. In 1832 the cholera was confined almost exclusively to the poor, and the deaths amounted to three hundred.

In 1849 the deaths in Hull (including the suburb of Sculcoates) were 1834, although 8,000 or 10,000 left the town, it is said, to avoid the ravages of the disease. Dr. Horner informed me that the deaths occurred amongst all classes of the community, and that the town was much better drained in 1849 than in 1832.

When the cholera made its appearance at York, about the middle of July 1849, it was at first chiefly prevalent in some narrow streets near the river, called the Water Lanes. The inhabitants of this spot had been in the habit, from time immemorial, of fetching their water from the river at a place near which one of the chief sewers of

the towns empties itself; and recently a public necessary had been built, the contents of which were washed every morning into the river just above the spot at which they got the water. In a short time from twenty to thirty deaths occurred in this locality; but the medical men considering the impure water injurious, the people were supplied from the water-works, with water obtained from the river at a point some distance above the town, and the cholera soon ceased nearly altogether in this part of the city, but continued to spread in some other parts. The cholera having thus abated in the Water Lanes, the gratuitous supply of water was cut off, and the people went to the river as before. There were still cases of cholera in the town, and it soon broke out again in this locality, and in the first few days of September eight deaths occurred among the persons who used water obtained direct from the river. The tap for general use was again opened, and the river water interdicted, and the cholera again ceased, and did not recur. These circumstances were communicated to me by a friend on whose accuracy I can rely.

The inhabitants of Dumfries drink the water of the river Nith, which flows through the town, and into which the sewers discharge their contents, which float afterwards to and fro with the tide. In 1832 there were 418 deaths from cholera out of a population of 11,606, being at the rate of 360 in 10,000, or 1 in every 28 of the inhabitants. The cholera again visited Dumfries at the close of 1848, and carried off 431 persons, or 1 in every 32, out of a population now numbering 14,000; so that the mortality was excessive on both occasions.

Preston and Oldham, in Lancashire, are supplied with water from surface drainage on the neighbouring hills, and there was scarcely any cholera at either of these

places in 1849. The greater part of the town of Paisley is supplied in a similar way ; and I was informed that the cases of cholera which occurred there in 1849 were confined to a quarter of the town to which this supply of water does not extend. Nottingham is supplied with filtered water obtained from the river Trent, some distance above the town. In 1832 this supply did not extend to all the inhabitants, and the cholera was somewhat prevalent amongst the poor, of whom it carried off 289 ; the population of the town being 53,000. After that time the water was extended copiously to all the inhabitants, and there were but thirteen deaths from the epidemic in 1849. The local Sanitary Committee placed the supply of water amongst the chief causes of this immunity from cholera, and I believe justly. There were but seven deaths from cholera in Nottingham last summer.

Glasgow has been supplied, since the early part of the present century, with the water of the Clyde, obtained a little way above the town, but within the influence of the tide, and consequently mixed with the contents of the sewers. It is imperfectly filtered through sand. In 1847, however, the parish of Gorbals, which forms the south part of Glasgow, was furnished with a supply of water collected on the neighbouring hills ; and Dr. Leech, of Glasgow, speaks as follows respecting the influence of this water on the prevalence of cholera : “ During the late cholera there was a remarkable circumstance, which deserves notice as compared with the epidemic of 1832. Since the former period, the population of Glasgow, south of the Clyde, has nearly doubled ; and with this exception, and the introduction of the soft-water supply, the circumstances might be considered as the same at both periods. In one district, the parish of Gorbals, the attack in 1832 was fearful ; while Glasgow, north of the Clyde,

also suffered severely. During the late epidemic [that of 1848-49], Gorbals parish furnished comparatively a small number of cases ; while the epidemic in other parts of Glasgow was very severe. The unanimous opinion of the Medical Society was, that this comparative immunity was to be attributed to the soft-water supply.”*

I was informed that when the cholera was prevalent in Glasgow last winter, the parish of Gorbals again enjoyed a similar immunity from the disease.

The following passage respecting the water-supply of Paris is from Dr. Farr’s “ Report to the Registrar-General on the Cholera of 1848-49”:—“ The supply of Paris is from various sources, but four-fifths of the water is from the Canal de l’Ourque, which, by the decision of Napoleon, was also appropriated to navigation. The water for some years, and in 1832, when the epidemic was so fatal, was drawn from the dirty basin in which the boats and barges of the canals rested ; but is now drawn from the canal before it enters the basin The mortality of cholera in Paris was excessive, and in 1832 varied from 80, of 10,000 inhabitants, in the elegant Chaussée d’Antin and in Montmartre on the heights, to 530 and 520 in the low quarters of the Hôtel de Ville and the Cité.” (p. lxxviii.)

The town of Newcastle-upon-Tyne affords a remarkable instance of the influence of the water supply on the prevalence of cholera. In 1831-32 there were no waterworks at Newcastle ; it was supplied, in an insufficient manner, with spring water, which generally had to be carried some distance to the houses from “ pants” in the streets. The epidemic was pretty severe at this time. From November 1831 to November 1832 there were 801 deaths from cholera out of a population of 42,760. The disease prevailed

* Report of the General Board of Health on the supply of Water to the Metropolis, 1850, p. 55.

chiefly amongst the poor, and was worst in the least elevated parts of the town, near the river. Subsequently to 1832, waterworks were established on the river Tyne, a little above the town ; but these were abandoned, in 1848, in favour of a supply from a rivulet and springs at Whittle Dean, about ten miles distant. In 1849, there were but 295 deaths from cholera in a population then increased to 71,847. In the beginning of July 1853, two months before the reappearance of cholera in England, the Whittle Dean Water Company found their proper sources insufficient for the demands of the population and the various factories, and they made use of the former waterworks, mentioned above, to obtain water from the Tyne. The point at which they obtained water from the river, is scarcely a mile above Newcastle, and the tide flows for six miles above the town, carrying the contents of the sewers with it. There are also villages, containing several thousands of colliers and ironfounders, on the banks of the Tyne, above the waterworks. The water from the Tyne was mixed, without filtration, with that from Whittle Dean, to the extent of one-third ; and the mixed water, so supplied, was discoloured, and contained the large quantity of 7·1 grains of organic matter per gallon.

In the autumn of 1853, the cholera was prevailing extensively at Hamburgh, and in nearly all the ports of the Baltic, whence a number of ships were arriving every day in the Tyne. The first cases of cholera commenced, with diarrhœa, on the 27th and 28th August, at Bell Quay, on the banks of the Tyne, three miles below Newcastle. One of the patients from Bell Quay was taken worse whilst on a visit to her mother at Newcastle : she died on 2nd September. Her mother was taken ill the same evening, and died on the following day. Other cases occurred in Newcastle on the 1st and 2nd of September, having no

connexion with these. A ship from Bremen was lying at Bell Quay, opposite the house where the first cases occurred; but there had been no illness on board this ship, and the precise way in which the cholera was introduced on this occasion, is not known.

The disease soon spread to an extent almost unprecedented in this country: by the 15th of September the deaths exceeded a hundred a day. In nine weeks there were 1,533 deaths from cholera in a population of 86,114, being 178 to each 10,000 inhabitants; but the greater number of these deaths occurred in a few days, as 1001 took place from the 13th to the 23rd Sept. inclusive.*

Gateshead, which is situated opposite to Newcastle, on the other side of the Tyne, is supplied with the same water; and in 1849 it shared with that town a comparative immunity from cholera, whilst in the autumn of 1853, 433 persons died of that disease out of a population of 26,000, or thereabouts, being 166 to each 10,000 inhabitants.

The lowest streets in Newcastle and Gateshead are about five feet above high-water mark; and only a few streets are situated at this level, for the banks rise very abruptly, at a little distance from the river, on both sides. A great portion of each town is elevated nearly 200 feet above the river, and some parts are nearly 300 feet high; yet the Water Company supplies all these districts, and all were severely visited by the cholera, which on this occasion spared no class of the community. In the districts which are most crowded, the mortality was greatest, the deaths being much more numerous in the parishes which contained a great number of tenements consisting of a single room, than in those which consisted chiefly of houses

* See Report of Commissioners on the Cholera at Newcastle, etc., p. 474.

occupied by one family.* This, however, is quite in accordance with the principles which I am throughout endeavouring to explain. A great deal of stress is laid, very properly, by the Commissioners who have reported respecting this outbreak, on the ill-arranged buildings, the defective drainage, and want of privy accommodation, in Newcastle ; but it must be remembered that all these evils existed in 1849, when Newcastle escaped with less cholera than most towns,—to a greater extent than they did in 1853, for many improvements had taken place in the meantime.

In consequence of a great outcry on the part of the public, who naturally connected the great fatality of cholera in some measure with the turbidity and offensive smell of the drinking-water, the Company entirely ceased to draw water from the Tyne on the 15th September ; and although the Tyne water was not entirely out of the pipes for a day or two, the deaths, which had been rapidly increasing, began to diminish on the 17th, and were lessened considerably by the 20th. The following is the course of the mortality in Newcastle, in the most fatal part of the epidemic ; and it began to decline at exactly the same time in Gateshead :

September	12	13	14	15	16	17	18	19	20	21	22	23.
DEATHS . . .	33	59	90	106	114	103	103	111	85	68	82	60.

The late General Board of Health directed one of their medical inspectors, Dr. Waller Lewis, to make minute inquiry as to the relative effects produced by the use of pure spring water, and that of the Water Company, during the epidemic of cholera in Newcastle ; and it is much to be regretted that the inquiry was not carried out. To have conducted the inquiry through the whole of New-

* *Opus cit.*, p. xxv.

castle and Gateshead would not have entailed a quarter as much labour as my investigations in Lambeth, Newington, and the Borough. Dr. Lewis called on Mr. Main, the secretary of the Water Company, and they made an inquiry in certain houses, taken at random, through three streets, and also in Greenhow Terrace, where a severe outbreak of cholera had occurred, although it was not supplied by the Company, but had what was reported to be good spring water. Dr. Lewis gave up the inquiry because he could not find two places exactly alike in all their physical conditions,—one place supplied with spring water, the other by the Company. He made no report of what he had done ; but Mr. Main sent a paper on the subject of this commenced inquiry to the Pathological Society of Newcastle, an abstract of which appeared in the “ Medical Times and Gazette”.

By adding Greenhow Terrace to the streets partly supplied by the Company, and by including cases of cholera, fatal or otherwise, with those of mere diarrhœa, Mr. Main was able to show a result apparently in favour of the Company's water. He was good enough, however, to send me a copy of his paper, which contains the details of the inquiry as far as it extended ; and I found, on perusing it, that, leaving out Greenhow Terrace, which is not supplied by the Company at all, there was no case of cholera, either fatal or otherwise, and no case, even of approaching cholera, in any house which was not supplied with the Company's water. All the deaths and all the cholera occurred in the houses having this water, whilst in the houses having only pump water, there was simply diarrhœa. In the workhouse, supplied by the Water Company, and having five hundred and forty inmates, there were twelve cases of cholera, or approaching cholera, and seven deaths ; whilst in the military barracks, supplied from

wells on the premises, and having five hundred and nineteen inmates, although there was a good deal of harmless diarrhæa, there was no cholera, nor any case of approaching cholera.

The communication of cholera by means of the water is well illustrated by the instance of Moscow, which was severely visited by that disease in 1830 ; but much less severely in the second epidemic. Subsequently to 1830 the greater part of the town, which is situated to the north of the Moscow river, obtained a supply of excellent water, conducted in pipes from springs at a distance ; and the cholera in 1847 was chiefly confined to those parts of the town which lie to the south of the river, to which the new supply of water did not extend, and where the people had still only impure river-water to drink.*

The above instances are probably sufficient to illustrate the widely-spread influence which the pollution of the drinking water exerts in the propagation of cholera.

After the Registrar-General alluded, in the " Weekly Return " of 14th October last, to the very conclusive investigation of the effects of polluted water in the south districts of London, there was a leading article, in nearly all the medical periodicals,† fully admitting the influence of the water on the mortality from cholera. It may therefore be safely concluded that this influence is pretty generally admitted by the profession. It must not be disguised, however, that medical men are not yet generally convinced that the disease is actually communicated from person to person by the morbid matter being swallowed in the drinking water, or otherwise. It used to be the custom of medical authors to speak of three kinds of causes

* Report of Swedish Commissioners, quoted in the Second Report of the Metropolitan Sanitary Commission, 1848.

† Medical Times and Gazette, Lancet, and Association Journal.

of a disease, viz. predisposing, exciting, and proximate causes. The proximate causes have been given up, as being the diseases themselves; but authors still divide causes into predisposing and exciting ones. It may be remarked, however, that in treating of certain communicable diseases, the cause of which is thoroughly understood, as syphilis and the itch, predisposing causes are never mentioned; and that they are rarely alluded to in treating of small-pox, measles, and scarlet fever, whilst they continue to be appealed to in explanation of the various continued fevers.* Now many medical men, whilst they admit the influence of polluted water on the prevalence of cholera, believe that it acts by predisposing or preparing the system to be acted on by some unknown cause of the disease existing in the atmosphere or elsewhere. The following amongst other reasons prove, however, that opinion cannot long halt here, and that, if the effect of contaminated water be admitted, it must lead to the conclusion that it acts by containing the true and specific cause of the malady.

In my inquiries in the south districts of London I met with several instances in which persons, especially maid-servants and young men, died of cholera within a few days after coming from the country to a house supplied with water by the Southwark and Vauxhall Company. The Registrar of Waterloo Road (2nd) remarked as follows on this point, on 26th August last:—"This is the third successive case of fatal cholera, where the patients have recently come from the country. Similar instances have frequently attracted the Registrar's notice." I found that the houses in which these cases occurred were supplied by

* Various conditions are requisite for the production of a disease, as they are for the production of a crop of wheat or turnips; but it is not necessary to dignify these conditions with the name of causes.

the above-named Company. The outbreak of cholera in the Baltic fleet, related at page 36, occurred within forty-eight hours after the polluted water had been taken on board. And lastly, if the contaminated water merely acted by predisposing or preparing the system to be affected by some other cause, it would be impossible to explain why nearly all the persons drinking it should be attacked together, in cases where a pump-well or some other limited supply is polluted, while the population around experience no increase of the malady.

All the evidence proving the communication of cholera through the medium of water, confirms that with which I set out, of its communication in the crowded habitations of the poor, in coal-mines and other places, by the hands getting soiled with the evacuations of the patients, and by small quantities of these evacuations being swallowed with the food, as paint is swallowed by house painters of uncleanly habits, who contract lead-colic in this way.

There are one or two objections to the mode of communication of cholera which I am endeavouring to establish, that deserve to be noticed. Messrs. Pearse and Marston state, in their account of the cases of cholera treated at the Newcastle Dispensary in 1853, that one of the dispensers drank by mistake some rice-water evacuation without any effect whatever.* In rejoinder to this negative incident, it may be remarked, that several conditions may be requisite to the communication of cholera with which we are as yet unacquainted. Certain conditions we know to be requisite to the communication of other diseases. Syphilis we know is only communicable in its primary stage, and vaccine lymph must be removed at a particular time to produce its proper effects. In the incident above

* Medical Times and Gazette, 1854, vol. i, p. 182.

mentioned, the large quantity of the evacuation taken might even prevent its action. It must be remembered that the effects of a morbid poison are never due to what first enters the system, but to the crop or progeny produced from this during a period of reproduction, termed the period of incubation ; and if a whole sack of grain, or seed of any kind, were put into a hole in the ground, it is very doubtful whether any crop whatever would be produced.

Dr. Thiersch is of opinion, as appears by a discussion which has recently taken place at Munich, that the cholera evacuations are not at first capable of generating the disease ; but that a decomposition takes place in them, and that in from six to nine days they become in a state to induce cholera. He founds this opinion on experiments which he performed by giving small quantities of the cholera evacuations to white mice. Although it is not contrary to all analogy that some change or development should take place in the cholera poison in the interval between its leaving one person and entering another, it is most probable that the fatal bowel complaint produced in white mice by Dr. Thiersch was not a specific disease, but the ordinary effect of putrifying ingesta. Many of the best attested instances of the communication of cholera are those, such as were related at the commencement of this work, where the patient is attacked in from twenty-four to forty-eight hours after first being near another patient, and although an interval of a week or so, often elapses between one case of the disease and those which follow, it is extremely probable that, in these instances, the evacuations remain the greater part of this time in a dry state on the soiled linen, without undergoing any change.

An objection that has repeatedly been made to the propagation of cholera through the medium of water, is, that

every one who drinks of the water ought to have the disease at once. This objection arises from mistaking the department of science to which the communication of cholera belongs, and looking on it as a question of chemistry, instead of one of natural history, as it undoubtedly is. It cannot be supposed that a morbid poison, which has the property, under suitable circumstances, of reproducing its kind, should be capable of being diluted indefinitely in water, like a chemical salt ; and therefore it is not to be presumed that the cholera-poison would be equally diffused through every particle of the water. The eggs of the tape-worm must undoubtedly pass down the sewers into the Thames, but it by no means follows that everybody who drinks a glass of the water should swallow one of the eggs. As regards the morbid matter of cholera, many other circumstances, besides the quantity of it which is present in a river at different periods of the epidemic, must influence the chances of its being swallowed, such as its remaining in a butt or other vessel till it is decomposed or devoured by animalcules, or its merely settling to the bottom and remaining there. In the case of the pump-well in Broad Street, Golden Square, if the cholera-poison was contained in the minute whitish floculi, visible on close inspection to the naked eye, some persons might drink of the water without taking any, as they soon settled to the bottom of the vessel.

It is not necessary to oppose any other theories in order to establish the principles I am endeavouring to explain, for the field I have entered on was almost unoccupied. The best attempt at explaining the phenomena of cholera, which previously existed, was probably that which supposed that the disease was communicated by effluvia given off from the patient into the surrounding air, and inhaled by others into the lungs ; but this view required

its advocates to draw very largely on what is called predisposition, in order to account for the numbers who approach near to the patient without being affected, whilst others acquire the disease without any near approach. It also failed entirely to account for the sudden and violent outbreaks of the disease, such as that which occurred in the neighbourhood of Golden Square.

Another view having a certain number of advocates is, that cholera depends on an unknown something in the atmosphere which becomes localized, and has its effects increased by the gases given off from decomposing animal and vegetable matters. This hypothesis is, however, rendered impossible by the motion of the atmosphere, and, even in the absence of wind, by the laws which govern the diffusion of aeriform bodies; moreover, the connection between cholera and offensive effluvia is by no means such as to indicate cause and effect; even in London, as was before mentioned, many places where offensive effluvia are very abundant have been visited very lightly by cholera, whilst the comparatively open and cleanly districts of Kennington and Clapham have suffered severely. If inquiry were made, a far closer connection would be found to exist between offensive effluvia and the itch, than between these effluvia and cholera; yet as the cause of itch is well known, we are quite aware that this connection is not one of cause and effect.

Mr. John Lea, of Cincinnati, has advanced what he calls a geological theory of cholera.* He supposes that the cholera-poison, which he believes to exist in the air about the sick, requires the existence of calcareous or magnesian salts in the drinking-water to give it effect. This view is not consistent with what we know of cholera,

* Cholera, with Reference to the Geological Theory. Cincinnati, 1850.

but there are certain circumstances related by Mr. Lea which deserve attention. He says that, in the western districts of the United States, the cholera passed round the arenacious, and spent its fury on the calcareous regions ; and that it attacked with deadly effect those who used the calcareous water, while it passed by those who used sandstone or soft water. He gives many instances of towns suffering severely when river water was used, whilst others, having only soft spring water or rain water, escaped almost entirely ; and he states that there has been scarcely a case of cholera in families who used only rain water. The rivers, it is evident, might be contaminated with the evacuations, whilst it is equally evident that the rain water could not be so polluted. As regards sand and all sandstone formations, they are well known to have the effect of oxidizing and thus destroying organic matters ; whilst the limestone might not have that effect, although I have no experience on that point. The connection which Mr. Lea has observed between cholera and the water is highly interesting, although it probably admits of a very different explanation from the one he has given.

There are certain circumstances connected with the history of cholera which admit of a satisfactory explanation according to the principles explained above, and consequently tend to confirm those principles. The first point I shall notice, viz., the period of duration of the epidemic in different places, refers merely to the communicability of the disease, without regard to the mode of communication. The duration of cholera in a place is usually in a direct proportion to the number of the population. The disease remains but two or three weeks in a village, two or three months in a good-sized town, whilst in

a great metropolis it often remains a whole year or longer. I find from an analysis which I made in 1849 of the valuable table of Dr. Wm. Merriman, of the cholera in England in 1832,* that fifty-two places are enumerated in which the disease continued less than fifty days, and that the average population of these places is 6,624. Forty-three places are likewise down in which the cholera lasted fifty days, but less than one hundred; the average population of these is 12,624. And there are, without including London, thirty-three places in which the epidemic continued one hundred days and upwards, the average population of which is 38,123; or if London be included, thirty-four places, with an average of 78,823. The following short table will show these figures in a more convenient form:—

No. of Places.		Duration in Days.	Average Population.	
52	...	0 to 50	...	6,624
43	...	50 to 100000	...	12,624
33 }	...	100 and upwards	...	{ 38,123
34 }				{ 78,823

There was a similar relation in 1849 between the duration of the cholera and the population of the places which it visited; a relation which points clearly to the propagation of the disease from patient to patient; for if each case were not connected with a previous one, but depended on some unknown atmospheric or telluric condition, there is no reason why the twenty cases which occur in a village should not be distributed over as long a period as the twenty hundred cases which occur in a large town.

Even the duration of the cholera in a street, when compared to its duration in the individual houses, points to the same conclusion. A table has been published† in the

* Trans. of Roy. Med. and Chir. Soc., 1844.

† Med. Times and Gazette, Nov. 25th, 1854.

report of the late discussion on cholera at Munich, which shows that whilst the epidemic remained three or four weeks in a street, it only remained six or seven days in houses where several people were attacked. Dr. Pettenkofer remarks, that “if the proximate cause of the disease had been generally diffused over a certain number of streets or a certain district, and its invasion had been opposed by individual disposition alone, one might have expected that both the cases of disease and the instances of death would have occurred in single houses, where many such appeared together, at similar periods of time throughout the whole street; but, supposing that the proximate cause of the disease was not general, but local, then it would act in such a manner that the period of time within which the disease would show itself in single houses would be very different from that which was applicable to the entire street.” The local cause in a house we know to be the illness of some individual, who, in many cases, has newly arrived from some place where the disease was prevailing.

Each time when cholera has been introduced into England in the autumn, it has made but little progress, and has lingered rather than flourished during the winter and spring, to increase gradually during the following summer, reach its climax at the latter part of summer, and decline somewhat rapidly as the cool days of autumn set in. In most parts of Scotland, on the contrary, cholera has each time run through its course in the winter immediately following its introduction. I have now to offer what I consider an explanation, to a great extent, of these peculiarities in the progress of cholera. The English people, as a general rule, do not drink much unboiled water, except in warm weather. They generally take tea, coffee, malt liquor, or some other artificial beverage at their

meals, and do not require to drink between meals, except when the weather is warm. In summer, however, a much greater quantity of drink is required, and it is much more usual to drink water at that season than in cold weather. Consequently, whilst the cholera is chiefly confined in winter to the crowded families of the poor, and to the mining population, who, as was before explained, eat each other's excrement at all times, it gains access as summer advances to the population of the towns, where there is a river which receives the sewers and supplies the drinking water at the same time; and, where pump-wells and other limited supplies of water happen to be contaminated with the contents of the drains and cess-pools, there is a greater opportunity for the disease to spread at a time when unboiled water is more freely used.

In Scotland, on the other hand, unboiled water is somewhat freely used at all times to mix with spirits; I am told that when two or three people enter a tavern in Scotland and ask for a gill of whiskey, a jug of water and tumbler-glasses are brought with it. Malt liquors are only consumed to a limited extent in Scotland, and when persons drink spirit without water, as they often do, it occasions thirst and obliges them to drink water afterwards.

There may be other causes besides the above which tend to assist the propagation of cholera in warm, more than in cold weather. It is not unlikely that insects, especially the common house-flies, aid in spreading the disease. An ingenious friend of mine has informed me that, when infusion of quassia has been placed in the room for the purpose of poisoning flies, he has more than once perceived the taste of it on his bread and butter.

Dr. Farr gives the following very important informa-

tion respecting the sex of persons who died of cholera at different periods of the epidemic.*

“It is worthy of remark, that at the beginning of the epidemic, the deaths of males exceeded the deaths of females very considerably ; the numbers in the months of October, November, and December, 1848, were,—males 612, females 493 ; or in the proportion of 100 to 80. . . .

“As a general rule, when the mortality from cholera attained a very high rate, the number of deaths among females exceeded the deaths among males.

“In London a remarkable change was observed in the proportion of the sexes affected in the course of the epidemic. In four weeks of October 1848, the deaths of 80 males and of 42 females by cholera were registered ; in the thirteen last weeks of the year the deaths of 258 males and 210 females were registered ; and there was an excess of males at all ages, but particularly in the ten years of age 15-25. In the quarter ending March 1849, the deaths of males amounted to 250, of females to 266 : at the age of 25 and upwards the excess of deaths among females was considerable. In June, at the commencement of the great outbreak, the males again furnished the most numerous victims. At the close of July the females died in greater numbers than the males, and continued to do so to the end. In the week that the mortality was highest, the deaths of 895 males and of 1131 females were returned. In the September quarter the deaths of males under the age of 25 exceeded the deaths of females ; but after that age the proportions were reversed.”

The greater part of the female population remain almost constantly at home, and take their meals at home, whilst a considerable number of the men move about in following their occupations, and take both food and drink at a

* Report on the Cholera of 1848-49, p. xl.

variety of places ; consequently, in the early part of an epidemic, when the disease only exists in a few spots, the male part of the population is most liable to come within the operation of the morbid poison ; but at a later period of the epidemic, when the cholera is more generally diffused, it may reach those who stay at home as readily as those who move about ; and in addition to the risk which the women share with the men, they have the additional one of being engaged in attending on the sick.

It is a confirmation of this view of the matter that, when the cholera poison is distributed through the pipes of a Water Company, the above rule does not hold good, but a contrary one prevails, owing, probably, to females being less in the habit of drinking beer than men, and being therefore more likely to drink water. Of the 334 deaths detailed in the Appendix to this work (286 of them amongst the customers of the Southwark and Vauxhall Water Company), only 147 were males, whilst 187 were females. The deaths occurred in the first four weeks of the recent epidemic. On the other hand, out of the 229 deaths from cholera which occurred in all the rest of London during this period, 140 were males and only 89 females. When the mortality of the whole of the metropolis during this period is taken together, there is a slight preponderance on the part of the males ; the numbers being,—males 287, females 276 : total 563.

The deaths from cholera in England in 1849 were 53,293 ; of those, 14,718, or 27 per cent. of the whole, occurred in children under 15 years of age. Of the 334 deaths which are recorded in the Appendix to this work, 127, or 38 per cent., are those of children under 15, whilst of the remaining 229 which occurred in the rest of London during the first four weeks of the epidemic, only 61, or 26 per cent., took place before the age of 15,—a

proportion nearly the same as in the whole of England in 1849. The higher proportion of deaths amongst children in the houses supplied with the impure water from the Thames at Battersea Fields, probably arose from the circumstance that children are very fond of drinking water in warm weather. I often heard such remarks as the following, in making my inquiries in the south districts of London:—"My children like water better than tea or anything else, I cannot keep them away from the water-butt;" or, "the child that is dead used to drink a great deal of that water, she was big enough to reach to the butt herself."

Dr. Guy, physician to King's College Hospital, made a table showing the occupations of 4,312 males, of fifteen years of age and upwards, who died of cholera in London in the epidemic of 1848-49; together with the ratio which the deaths bear to the living, as well as it could be ascertained from the census of 1841. I have not room for the whole table, but have selected the occupations which suffered most, and those which suffered least. The following abstract of Dr. Guy's table contains all the occupations where the deaths from cholera equalled one-fiftieth of the number living, and all those in which the deaths did not exceed one in two hundred and fifty living.

In some of the occupations which show a high relative mortality, the number of living is too small to allow of any reliable statistical result, and the relative mortality is probably due to accidental circumstances quite unconnected with the occupation. In other cases, however, the numbers are so considerable as to indicate something more than accident. The 299 sailors, for instance, constituted one twenty-fourth of the whole estimated number in that occupation. The 7 ballast-heavers form just the

same proportion of the whole in that occupation, and the 53 coalporters and coalheavers constituted one in 32 of those so employed. Now all those persons lived or were employed on the river, where it is the habit to drink water drawn by pailfuls from the side of the ship. The 67 hawkers are one in 22 of the whole number. These persons are constantly moving about, and are in the habit of living in crowded lodging-houses, and consequently must be extremely liable to contract any communicable disease. Tanners nearly all live in Bermondsey and Lambeth, supplied in 1849 with none but very impure water, as was previously explained. The weavers probably suffered the high rate of mortality from the crowding of their apartments in Spitalfields, and the uncleanness of their habits.

The persons who suffered less from cholera than any other part of the male population, are footmen and men-servants; and it is impossible to conceive a class less exposed to the disease. They live in the best parts of London, and go from home much less than their masters. The low rate of mortality amongst medical men and undertakers is worthy of notice. If cholera were propagated by effluvia given off from the patient, or the dead body, as used to be the opinion of those who believed in its communicability; or, if it depended on effluvia lurking about what are by others called infected localities, in either case medical men and undertakers would be peculiarly liable to the disease; but, according to the principles explained in this treatise, there is no reason why these callings should particularly expose persons to the malady.

There is one remarkable circumstance connected with Dr. Guy's table. One master-brewer died of cholera, being 1 in 160 of the trade; but no brewer's man or brewer's servant is mentioned as having died of this

TABLE XIV.

	No. of Deaths.	Ratio.
Agents	12	1 in 49
Bricklayers and builders	14	1 „ 39
Cowkeepers, dairymen, and milkmen	8	1 „ 20
Egg merchants	5	1 „ 6
Fishmongers	11	1 „ 20
Fruiterers and greengrocers	12	1 „ 28
Jobmasters, livery-stable keepers	5	1 „ 37
Oilmen	13	1 „ 46
Paper-makers	2	1 „ 15
Poulterers	3	1 „ 32
Sail-makers	2	1 „ 30
Turners	2	1 „ 50
Ballast-heavers	7	1 „ 24
Coal-porters and coal-heavers	53	1 „ 32
Dustmen and scavengers	6	1 „ 39
Founders	10	1 „ 12
Hawkers, etc.	67	1 „ 22
Lithographers	3	1 „ 48
Modellers	3	1 „ 41
Polishers	4	1 „ 36
Sailors, including Greenwich pensioners	299	1 „ 24
Tanners	22	1 „ 39
Weavers	102	1 „ 36
Physicians, surgeons, & general practitioners	16	1 „ 265
Magistrates, barristers, conveyancers, and attorneys	13	1 „ 375
Merchants	11	1 „ 348
Auctioneers	1	1 „ 266
Saddlers	1	1 „ 250
Brass-finishers	3	1 „ 318
Coach-makers	16	1 „ 262
Cork-cutters	2	1 „ 279
Footmen and men-servants	25	1 „ 1572
Jewellers, goldsmiths, and silversmiths	6	1 „ 583
Millwrights	2	1 „ 266
Tallow-chandlers	2	1 „ 430
Type-founders	1	1 „ 390
Undertakers	2	1 „ 325
Warehousemen	8	1 „ 472
Watchmakers	11	1 „ 364
Wheelwrights	8	1 „ 294

malady, although these men must constitute a very numerous body in London. There must be a few thousands of them. I have, indeed, met with the deaths of two or three of these persons, in looking over the returns of some of the most fatal weeks in 1849; but the brewers' men seem to have suffered very slightly both in that and the more recent epidemics. The reason of this probably is, that they never drink water, and are therefore exempted from imbibing the cholera poison in that vehicle.

/ The great prevalence of cholera along the course of rivers has been well known for a quarter of a century; and it meets with a satisfactory explanation from the mode of communication of the disease which I am inculcating. Rivers always receive the refuse of those living on the banks, and they nearly always supply, at the same time, the drinking water of the community so situated. It has sometimes been objected to the propagation of the disease by the water of rivers, that the epidemic travels as often against the stream as with it.* The reply to this is, that people travel both against the stream and with it, and thus convey the malady from village to village and from town to town on the banks, whilst the water serves as a medium to propagate the disease amongst those living at each spot, and thus prevents it from dying out through not reaching fresh victims.

The principles I have laid down afford a satisfactory explanation of the circumstances, that absence of drainage promotes the prevalence of cholera, and that it flourishes better on a clay soil than on primitive rocks, sandstone, or gravel. Without drainage, the refuse of the population permeates the ground, and gains access to the pump-wells. Merthyr Tydvil, with 52,863 inhabitants, is entirely without drainage, and the people derive their supply of water from pump-wells. This place has suffered severely from

cholera in every epidemic. In 1849 there were 1,682 deaths from this disease, being 234 to each 10,000 inhabitants,—a rate of mortality as high as in Hull and certain of the south districts of London, where the morbid poison of cholera was distributed by the steam-engines of the water companies. The primitive rocks, sandstone, and gravel, generally cause the purification of the water by the separation or oxidation of organic matters, whilst clay does not exert this salutary influence to the same extent.

Since the latter part of 1848, when I first arrived at my present conclusions respecting the mode of communication of cholera, I have become more and more convinced that many other diseases are propagated in the same way.

When the plague visited this country, it was most fatal in London, York, Winchester, and certain other towns having a river of fresh water passing through them. It resembled cholera also in being twice as fatal in the districts on the south of the Thames as in those on the north. The following passage from Stow's "Survey", published in 1633, shows the way in which Southwark was supplied with water about the time of the great visitations of plague : "Southwark useth chiefly the water of the Thames, that falls into a great pond at St. Mary Overies, that drives a mill called St. Saviour's Mill, the owner whereof is one Mr. Gulston. The revenue thereof is supposed by some to be worth 1,300*l.* a year."

Although some of the lower parts of the City were supplied with water from the Thames, at the latter part of the sixteenth and throughout the seventeenth century, yet the greater part of London north of the Thames was supplied by fountains and conduits, conveying spring water from a distance. The following quaint but poetic account

of the conduits of London cannot fail to be interesting :
“ As nature, by veins and arteries, some great and some small, placed up and down all parts of the body, ministereth blood to every part thereof ; so was that wholesome water, which was necessary for the good of London, as blood is for the good and health of the body, conveyed by pipes, wooden or metalline, as by veins, to every part of this famous city They were lovely streams indeed that did refresh that noble city, one of which was always at work pouring out itself when the rest lay still. Methinks these several conduits of London stood like so many little but strong forts, to confront and give check to that great enemy, fire, as occasion should be. There, methinks, the water was intrenched and in-garrisoned. The several pipes and vehicles of water that were within these conduits, all of them charged with water, till by turning of the cock they were discharged again, were as so many soldiers within these forts, with their musketry charged, ready to keep and defend these places. And look how enemies are wont to deal with these castles, which they take to be impregnable, and despair of every getting by them,—that is, by attempting to storm them by a close siege : so went the fire to work with these little castles of stone, which were not easy for it to burn down (witness their standing to this day) ; spoiled them, or almost spoiled them, it hath for the present, by cutting off those supplies of water which had vent to flow to them, melting those leaden channels by which it had been conveyed, and thereby, as it were, starving those garrisons which it could not take by storm. As if the fire had been angry with the poor old tankard-bearers, both men and women, for propagating that element which was contrary to it, and carrying it upon their shoulders, as it were, in state and triumph, it hath even destroyed their trade, and threatens

to make them perish by fire who had wont to live by water.”*

Dr. Farr makes the following remarks on the plague, in his report on the cholera of 1848-9 : “ It is endemic in the Delta of the Nile, and periodically decimates the population of Cairo and Alexandria It grows gradually less fatal up the Nile, and is less frequent and destructive in Upper than in Lower Egypt, in the high lands and in the desert, than on the low lands on the shores of the Mediterranean.” Speaking of Cairo, he says : “ Through the midst of it passes the Great Canal, into which the sewers are discharged over carrion, excretion, and mud. At the yearly overflow of the Nile, its waters, filling this canal, are distributed over the city, and drunk by its wretched inhabitants.”

The plague resembles cholera in being much promoted by crowding and want of personal cleanliness. The natives of Gurhwal, a province in the north-west of British India, in which the plague has been present for the last thirty years, believe that it may be transmitted from one place to another in articles of diet, such as a jar of ghee.†

Yellow fever, which has been clearly proved by Dr. M’William and others to be a communicable disease, resembles cholera and the plague in flourishing best, as a general rule, on low alluvial soil, and also in spreading greatly where there is a want of personal cleanliness. This disease has more than once appeared in ships sailing up the river Plate, before they have had any communication with the shore. The most probable cause of this circumstance is, that the fresh water of this river, taken up from alongside the ship, contained the evacuations of patients with yellow fever in La Plata or other towns.

* Rolle’s Account of the Burning of London in 1666.

† Official Reports on the Province of Kumaon, by J. H. Batten, Esq., C.E. Agra, 1851.

It was long ago observed, that dysentery was apparently propagated by the drinking of water containing excrementitious matters.* The frequent appearance of this disease in Millbank prison, when the Thames water was used, is a confirmation of this ; and Dr. Bryson has lately related a number of instances where both dysentery and fever seemed to be occasioned by the water of the Yangtse-Kiang, the Canton river, and other rivers of China.† What very much confirms this view of the case, is, that nearly all the patients were afflicted with great numbers of intestinal worms (*lumbrici*) ; for it cannot be supposed that the worms could proceed from malaria, miasmata, or any of the causes which are frequently believed to occasion dysentery and fever. The eggs of the *lumbrici* were no doubt contained in great numbers in the water of the densely populated Chinese rivers.

There are many facts which indicate that one at least of the continued fevers—the typhoid fever with ulceration of the small intestines—is also propagated in the same way as cholera. Dr. Jenner called my attention some time ago to an instance occurring at the village of North Boston, Erie County, N.Y., in which typhoid fever was probably communicated to a number of families by the contamination of the water of a well which they used.‡ The epidemic which prevailed so extensively at Croydon two years ago was of this character, as was verified by a Committee of the Epidemiological Society, of which Drs. Sankey, Jenner, and A. P. Stewart were members. Mr. Carpenter, of Croydon, has lately shown very ably that this epidemic was connected with the pollution of the

* Dr. Cheyne on Dysentery, Dublin Hospital Reports, vol. iii.

† Statistical Reports on the Health of the Navy. Part II. 1853.

‡ See Clinical Reports of Continued Fever, by Austin Flint, M.D.: Buffalo, 1852, p. 380. Also Med. Times and Gazette, March 12, 1853, p. 261.

pump-wells of the town, owing to the disturbance of the ground, and of many old cesspools during the drainage operations of the Local Board of Health.* The Board had supplied the town with good water from a deep well in the chalk, but the population had a prejudice against it and persisted in resorting to the water of the shallow pump-wells. In the autumn of last year diarrhœa was very prevalent in Croydon, and Mr. Carpenter found that this also was caused by the impure water of the pump-wells. Nine-tenths of the people of Croydon were drinking the new water supplied by the Board of Health, but, out of thirty-two patients with diarrhœa who came under the notice of Mr. Carpenter, twenty-five were drinking well-water entirely, five drank water from both sources, and the other two could not decidedly say that they had not drank well-water.

Intermittent fevers are so fixed to particular places that they have deservedly obtained the name of endemics. They spread occasionally, however, much beyond their ordinary localities, and become epidemic. Intermittent fevers are undoubtedly often connected with a marshy state of the soil; for draining the land frequently causes their disappearance. They sometimes, however, exist as endemics, where there is no marshy land or stagnant water within scores of miles. Towards the end of the seventeenth century, intermittent fevers were, for the first time, attributed by Lancisi to noxious effluvia arising from marshes. These supposed effluvia, or marsh miasmata, as they were afterwards called, were thought to arise from decomposing vegetable and animal matter; but, as intermittent fevers have prevailed in many places where there was no decomposing vegetable or animal matter, this opinion has been given up in a great mea-

* Association Journal, October 6, 1854.

sure ; still the belief in miasmata or malaria of some kind, as a cause of intermittents, is very general. It must be acknowledged, however, that there is no direct proof of the existence of malaria or miasmata, much less of their nature.

That preventive of ague, draining the land, must affect the water of a district quite as much as it affects the air, and there is direct evidence to prove that intermittent fever has, at all events in some cases, been caused by drinking the water of marshes. In the "General Report of the Poor Law Commissioners on the Sanitary Condition of Great Britain,"* Mr. Wm. Blower, surgeon, of Bedford, states that typhus and ague, which had long infested the village of Wootton, near Bedford, had been much diminished by digging a few wells, and obtaining good water. He also states that, in the neighbouring parish of Houghton, almost the only family which escaped ague, at one time, was that of a respectable farmer who used well water, whilst all the other families had only ditch water.

M. Boudin† relates a very marked instance in which intermittent, and apparently also remittent, fever were caused by drinking marsh water. It is as follows :—

"In July 1834, 800 soldiers, all in good health, embarked on the same day in three transports at Bona, in Algeria, and arrived together at Marseilles ; they were exposed to the same atmospheric influences, and were, with one essential difference, supplied with the same food, and subjected to the same discipline. On board one of the vessels were 120 soldiers : of these, 13 died on the passage, from a destructive fever, and 98 more were taken to the military hospital of the lazaretto at Marseilles, presenting all the pathological characters proper to marshy

* 8vo., 1842, p. 66.

† *Essai de Géographie Médicale*, p. 52.

localities. On seeing the physiognomy of these patients, altogether so unusual for Marseilles, one would have said that the Gulf of Mexico, the Delta of the Ganges, and the marshes of Senegal and of Holland, had supplied passengers to this ship. In short, by the side of a simple intermittent, there was a pernicious fever. On an inquiry being instituted, it was ascertained that on board the affected ship the water supplied for the soldiers, owing to the haste of the embarkation, had been taken from a marshy place near Bona; whilst the crew, not one of whom was attacked, were supplied with wholesome water. It further appeared that the nine soldiers who had escaped had purchased water of the crew, and had consequently not drunk the marsh water. Not a single soldier or sailor of the other two transports, who were supplied with pure water, suffered."

Mr. Grainger, who quotes the above circumstance in his Appendix to the Report on Cholera, also says :* " Dr. Evans, of Bedford, related to me an equally well-marked instance. A few years ago, he was staying at Versailles, with his lady, when they both became affected with the ague, and, on inquiry, the following facts were disclosed. The town of Versailles is supplied with water for domestic purposes from the Seine, at Marli. At the time in question, a large tank, supplying one particular quarter, was damaged, and the mayor, without consulting the medical authorities, provided a supply of water, consisting of the surface-drainage of the surrounding country, which is of a marshy character. The regular inhabitants would not use this polluted water; but Dr. and Mrs. Evans, who were at an hotel, drank of it unwittingly, and it was also used by a regiment of cavalry. The result was, that those who drank the water suffered from inter-

* Page 94.

mittent fever of so severe a type, that seven or eight of the soldiers, fine young men, died on one day, Sept. 1, 1845. On a careful investigation it was ascertained that those only of the troops who had drunk the marsh water were attacked ; all the others, though breathing the same atmosphere, having escaped, as did also the townspeople.”

In all the instances I have just quoted, the cause of ague, whatever it may be, was swallowed with the water, not inhaled with the air ; and on questioning two patients, ill with this complaint, in St. George’s Hospital, after harvesting in Kent, they told me that they had often been obliged to drink water from the ditches. The disease of the liver and spleen, to which persons are subject after attacks of intermittent fever, also confirms the view that its material cause enters the system by the alimentary canal, and not by the lungs ; and it is of importance to remark, that Hippocrates observed, that drinking stagnating waters caused hard swellings of the spleen.*

Whether the unknown cause of ague has been produced in the system of a previous patient, like the pus of small-pox and the eggs of tape-worm, or whether it has been produced externally, there is, at present, no sufficient evidence to show. In the case first supposed, the disease would be a communicable one, in the second it would not.

There is one circumstance which seems to indicate that the specific cause of intermittent fevers undergoes a development or multiplication within the system of the patient,—it is, that a period of dormancy, or incubation, has been observed, in many cases, between the visit to the unhealthy locality and the illness which followed ; for, as I have already remarked, every poisonous or injurious substance causes symptoms as soon as it has been absorbed in sufficient quantity.

* De Aere, Aquis, et Locis.

The communication of ague from person to person has not been observed, and supposing this disease to be communicable, it may be so only indirectly, for the *materies morbi* eliminated from one patient may require to undergo a process of development or procreation out of the body before it enters another patient, like certain flukes infesting some of the lower animals, and procreating by alternate generations.

The measures which are required for the prevention of cholera, and all diseases which are communicated in the same way as cholera, are of a very simple kind. They may be divided into those which may be carried out in the presence of an epidemic, and those which, as they require time, should be taken beforehand.

The measures which should be adopted during the presence of cholera may be enumerated as follows :—

1st. The strictest cleanliness should be observed by those about the sick. There should be a hand-basin, water, and towel, in every room where there is a cholera patient, and care should be taken that they are frequently used by the nurse and other attendants, more particularly before touching any food.

2nd. The soiled bed linen and body linen of the patient should be immersed in water as soon as they are removed, until such time as they can be washed, lest the evacuations should become dry, and be wafted about as a fine dust. Articles of bedding and clothing which cannot be washed, should be exposed for some time to a temperature of 212° or upwards.

3rd. Care should be taken that the water employed for drinking and preparing food (whether it come from a pump-well, or be conveyed in pipes) is not contaminated with the contents of cesspools, house-drains, or sewers ;

or, in the event that water free from suspicion cannot be obtained, it should be well boiled, and, if possible, also filtered.

Works are in progress for supplying a great part of London with water from the Thames, obtained, like that of the Lambeth Company, above Teddington Lock. Although this is not the best possible source for supplying a large town, it is a great improvement on the practice of many of the water companies ; and the water, owing to filtration, and especially to its detention in large reservoirs, will probably be quite salubrious : at all events it will be much safer than that of the shallow pump-wells of London, which are fed from very polluted sources. It is very desirable that the handles of nearly all the street-pumps of London and other large towns should be fastened up, and the water used only for such purposes as watering the streets. A proper supply of water for the shipping in the Thames is much wanted. Water acquires a flat taste by being boiled ; but if it is filtered after it becomes cold, it gets re-aerated, and the flat or vapid taste is entirely removed.

4th. When cholera prevails very much in the neighbourhood, all the provisions which are brought into the house should be well washed with clean water, and exposed to a temperature of 212° Fahr. ; or at least they should undergo one of these processes, and be purified either by water or by fire. By being careful to wash the hands, and taking due precautions with regard to food, I consider that a person may spend his time amongst cholera patients without exposing himself to any danger.

5th. When a case of cholera or other communicable disease appears among persons living in a crowded room, the healthy should be removed to another apartment, where it is practicable, leaving only those who are useful to wait on the sick.

6th. As it would be impossible to clean out coal-pits, and establish privies and lavatories in them, or even to provide the means of eating a meal with anything like common decency, the time of working should be divided into periods of four hours instead of eight, so that the pit-men might go home to their meals, and be prevented from taking food into the mines.

7th. The communicability of cholera ought not to be disguised from the people, under the idea that the knowledge of it would cause a panic, or occasion the sick to be deserted.

British people would not desert their friends or relatives in illness, though they should incur danger by attending to them ; but the truth is, that to look on cholera as a “ catching” disease, which one may avoid by a few simple precautions, is a much less discouraging doctrine than that which supposes it to depend on some mysterious state of the atmosphere in which we are all of us immersed and obliged to breathe.

The measures which can be taken beforehand to provide against cholera and other epidemic diseases, which are communicated in a similar way, are—

8th. To effect good and perfect drainage.

9th. To provide an ample supply of water quite free from contamination with the contents of sewers, cesspools, and house-drains, or the refuse of people who navigate the rivers.

10th. To provide model lodging-houses for the vagrant class, and sufficient house room for the poor generally.

The great benefit of the model lodging-houses arises from the circumstance that the apartments for cooking, eating, and sleeping, are distinct, and that all the proper offices which cleanliness and decency require are provided. The very poor who choose to avail themselves of these institutions, suffer a rate of mortality as low as that of the most

opulent classes. The public wash-houses, which enable poor persons to wash the soiled linen of the sick or the healthy, without doing it in the midst of the plates and dishes and provisions of the family, are well calculated to prevent the spread of disease.

11th. To inculcate habits of personal and domestic cleanliness among the people everywhere.

12th. Some attention should undoubtedly be directed to persons, and especially ships, arriving from infected places, in order to segregate the sick from the healthy. In the instance of cholera, the supervision would generally not require to be of long duration.

In the autumn of 1853, certain German emigrants, on their way to America, who had crossed the sea from Hamburg and Rotterdam, where cholera was prevailing, to the port of Hull, and had gone thence, by rail, to Liverpool, were seized with cholera (some of them fatally) in the latter town ; and it is most likely to the well-regulated Emigrant's Home, in which these cases occurred, that the town of Liverpool owed its freedom from the epidemic at that time. And a little medical supervision, and the detention of some of the emigrants for a short time in Liverpool, before their embarkation, would probably have prevented the great mortality which occurred in some of the emigrant ships during their passage to America.

The measures which are intended to prevent disease should be founded on a correct knowledge of its causes. For want of this knowledge, the efforts which have been made to oppose cholera have often had a contrary effect. In 1849, for instance, the sewers of London were frequently flushed with water,—a measure which was calculated to increase the disease in two ways : first, by driving the cholera evacuations into the river before there was time for the poison to be rendered inert by decomposition ; and second, by making increased calls on the various com-

panies for water to flush the sewers with,—so that the water which they sent to their customers remained for a shorter time in the reservoirs before being distributed. It should be remarked, also, that the contents of the sewers were driven into the Thames by the flushing, at low water, and remained flowing up the stream for four or five hours afterwards. Flushing the sewers was not repeated during the recent epidemic, but increased quantities of water were distributed by some of the Companies, and at more frequent intervals, causing the water-butts to overflow for hours together into the drains, and producing nearly the same effect as flushing the sewers ; in addition to which, the water in the butts of the Southwark and Vauxhall Company's customers was prevented from settling, as it might have done if less frequently disturbed.

I feel confident, however, that by attending to the above-mentioned precautions, which I consider to be based on a correct knowledge of the cause of cholera, this disease may be rendered extremely rare, if indeed it may not be altogether banished from civilized countries. And the diminution of mortality ought not to stop with cholera. The deaths registered under the name of typhus consist chiefly of the typhoid fever mentioned above. Its victims are composed chiefly of persons of adult age, who are taken away from their families and connections. In 1847 upwards of 20,000 deaths were registered in England from typhus, and in 1848 upwards of 30,000 deaths. It is probable that seven times as many deaths have taken place from typhus as from cholera, since the latter disease first visited England in 1831 ; and there is great reason to hope that this mortality may in future be prevented by proper precautions, resulting from a correct knowledge of the mode of communication of the malady.

APPENDIX,

Containing the number of deaths from cholera registered in the four weeks ending 5th August, 1854, together with the supply of water in the houses in which the fatal attacks took place, in all the sub-districts to which the water supply of either the Southwark and Vauxhall or the Lambeth Company extends. (See Table VII, page 84.) The registers of deaths are copied from the Weekly Returns of the Registrar General.

ST. SAVIOUR, SOUTHWARK. *Christchurch.*

At 34, Charlotte Street, on 29th July, a stock-maker, aged 29, " Asiatic cholera 18 hours" . . . *Lambeth.*

At 45, Gravel Lane, on 1st August, the widow of a farmer, aged 48, " cholera 12 hours". *Southwark & Vauxhall.*

At 1, Alpha Place, on 1st August, a barrister's clerk, aged 57, " cholera 24 hours". *Southwark and Vauxhall.*

ST. SAVIOUR, SOUTHWARK. *St. Saviour.*

At 1, Park Street, on 25th July, the wife of a labourer, aged 35, " Asiatic cholera 14½ hours". *Southwark & Vauxhall.*

At 40, Bankside, on 25th July, the son of a locksmith, aged 5 years, " cholera 12 hours" *Southwark and Vauxhall.*

At same house, on 26th July, the daughter of a locksmith, aged 9 yrs., " cholera 12 hours". *Southwark and Vauxhall.*

At same house, on 28th July, the daughter of a locksmith, aged 13 yrs., " cholera 12 hours". *Southwark and Vauxhall.*

At 97, Bridge Road, on 28th July, a hatter, aged 36, " Asiatic cholera 24 hours" . . . *Southwark and Vauxhall.*

At 49, Great Guildford Street, on 29th July, a coal-porter, aged 44, " cholera 12 hours". *Southwark and Vauxhall.*

At 20, Zoar Street, on 31st July, a female, formerly a domestic servant, aged 79, "diarrhœa 2 days, cholera 12 hours" *Southwark and Vauxhall.*

At 22, America Street, on Aug. 1, the wife of an engine-driver, aged 38, "cholera 12 hours". *Southwark and Vauxhall.*

At 5, Pleasant Place, August 1, the daughter of a coal-porter, aged 5 years, "Asiatic cholera 13 hours".

Southwark and Vauxhall.

At 10, Castle Street, on 1st August, the son of an engineer, aged 7 years, "cholera 12 hours".

Southwark and Vauxhall.

At 36, New Park Street, on 1st August, the son of an artist, aged 2 years, "Asiatic cholera 10½ hours".

Thames water from the tank of a saw-mill.

At 54½, Great Guildford St., on 2nd Aug., a labourer aged 51, "Asiatic cholera 47 hours". *Southwark and Vauxhall.*

At the same house, same day, the wife of a labourer, aged 48, "Asiatic cholera 12½ hours". *Southwark and Vauxhall.*

At 2, Emerson Place, on 3rd August, the wife of an engineer, aged 30, "cholera 2 days". *Southwark and Vauxhall.*

At 29, Norfolk St., on 2d Aug., the son of a labourer, aged 3 years, "Asiatic cholera 12½ hours".

Southwark and Vauxhall.

At 68, Great Guildford St., on 3rd Aug., the widow of a labourer, aged 40, "cholera 19 hours". *Southwark and Vauxhall.*

At 10, Castle Street, on 3rd August, the daughter of a labourer, aged 4 years, "cholera 12 hours".

Southwark and Vauxhall.

At White Hart Inn Yard, on 3rd August, the wife of a porter, aged 49. "cholera 14 hours". *Southwark and Vauxhall.*

At 22, America Street, on 3rd August, an engine-driver, aged 35, "cholera 9 hours". *Southwark and Vauxhall.*

At 15, Essex Street, on 4th August, a packer, aged 65, "diarrhœa 4 days, cholera 11 hours". *Southwark and Vauxhall.*

In the original publication the list of deaths is continued in this form for a total of twenty-five pages.

ON CONTINUOUS MOLECULAR CHANGES

ON

CONTINUOUS MOLECULAR CHANGES,

MORE PARTICULARLY IN THEIR RELATION TO

EPIDEMIC DISEASES:

BEING THE

Oration

DELIVERED AT THE 80th ANNIVERSARY

OF THE

MEDICAL SOCIETY OF LONDON.

BY

JOHN SNOW, M.D.

VICE-PRESIDENT OF THE SOCIETY.

PUBLISHED BY REQUEST OF THE SOCIETY.

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1853.

PREFACE.

THE title to these pages may, perhaps, seem rather obscure, on account of the various senses in which the word molecular has at different times been employed. I do not, however, know any better term by which to express all that refers to the attraction which exists amongst the particles of matter at insensible distances.

The word chemical is restricted to expressing what relates to the composition of bodies, and does not include properties, such as solidity and fluidity, which are called physical ; nor some of the processes that we call vital, such as the formation of fibres and cells. It is especially desirable to have a general term to include what is understood by the words physical, chemical, and vital, in order to avoid the disputes respecting these two latter words, (disputes in which we see such authors as Humboldt, Liebig, and Alison engaged,) and the needless antagonism in which these words are sometimes placed towards each other.

All changes of composition whatever, whether occurring in a test-tube, or in the living brain, are properly

included amongst chemical changes ; and all that takes place in living structures has a right to be called vital, whether it differs from what occurs elsewhere or not. Thus, whilst the terms chemical and vital have each a separate signification, they have a certain ground in common, since changes of composition in living beings are at once both chemical and vital, and belong to both chemistry and physiology ; just as fossil animals belong to both the mineral and animal kingdoms, and to the sciences of geology and zoology at the same time. To dispute whether the formation of urea or cholesterine is a chemical or vital process, is as useless as it would be to dispute whether a fossil ichthyosaurus is a mineral or an animal, and whether it belongs to geology or zoology.

I beg the reader to remember that the term oration proceeds from the laws of the Medical Society, and not from any claim of mine to be considered an orator.

18, SACKVILLE STREET :

March 26, 1853.

ON

CONTINUOUS MOLECULAR CHANGES.

THE Medical Society of London having conferred on me the honour of electing me to deliver the oration for the present year, I have much pleasure in accepting the duty, and shall endeavour to perform it to the best of my ability. No restrictions are imposed by the Society with respect to the precise subject of the oration ; but the nature of the appointment implies that the discourse should refer to the Society, or to the science which it is its object to cultivate. It is usually, and very properly, the custom on these occasions to treat of the past history, present state, and future prospects of the Society ; but it is obviously not imperative that these matters should form the subject of every anniversary oration, especially as they are well known to the greater number of the Fellows.

It is my intention on the present occasion to make a few remarks on some of the chief phenomena of living beings.

The principal forces with which we are acquainted are, the attraction which the atoms of matter exert on each other at all distances, and the attraction which exists only at insensible distances. The first of these forces is called the attraction of gravitation ; and the term chemical attraction, or chemical affinity, includes more or less of the second force, according to the more or less extended sense in which the word chemistry is understood. The effects of gravitation on living beings are of a simple kind, and are

pretty well known ; therefore they need not detain us. With respect, however, to the attraction which takes place at insensible distances, the case is different. The results of this attraction in living beings are very complicated and important, and they require much investigation.

The attraction of gravitation is a constantly operating force, even when it leads to no relative change of position ; and in like manner the attraction at insensible distances is equally constant in its action under all circumstances, whether it is causing changes of composition and arrangement, or merely holding together the particles of a metal, or preventing changes in a compound body, by a balance of affinities. The attraction amongst adjoining particles of matter may be very feeble, but it is probably never altogether absent. Eminent chemists tell us, indeed, when speaking of atmospheric air, that “the nitrogen manifests no attraction for the oxygen,” and that “all bodies which have an affinity for oxygen abstract it from the atmosphere with as much facility as if the nitrogen was absent altogether.”* But this is not quite correct. A red hot iron wire is incapable of abstracting oxygen from the atmosphere, although it combines very briskly with that gas in the absence of the nitrogen. A lighted candle, or a piece of ignited charcoal, has the power of abstracting only about one-fourth of the oxygen from a limited quantity of air, when the combustion ceases, whilst in the absence of the nitrogen it would consume nearly the whole of the oxygen. When animals are placed in an atmosphere made by mixing together equal parts of nitrogen gas and atmospheric air, and therefore containing just half the ordinary amount of oxygen, they exhibit more distress, and die much sooner, than in an atmosphere of the same extent, in which the oxygen and the nitrogen are both reduced to one half, by the air-pump.

* Turner's Chemistry, by Liebig and Gregory, 8th ed. p. 206.

It is evident, then, that the nitrogen of the air exerts an influence over the combination of oxygen with other bodies. This depends chiefly on the affinity between the nitrogen and the oxygen—an affinity which is not great enough to cause their combination under ordinary circumstances, but is sufficient to counterbalance, to a certain extent, the affinity between oxygen and other bodies. It is on this kind of counter-affinity, as it may be called, that the action of most narcotic and antiseptic agents on living and dead animal substances depends.*

The phenomena of cohesion and crystallization shew that the attraction at insensible distances exists amongst the molecules or atoms of the same kind of matter, as well as of different kinds. There are other circumstances which illustrate the same principles. For instance, Professor Graham found that phosphorus is not acted on by pure oxygen, at the ordinary temperature and pressure of the atmosphere, but on diminishing the pressure or adding a little nitrogen the phosphorus begins to be oxidized.† The reason of this probably is that the attraction of the molecules of oxygen for each other prevents their union with the phosphorus, till this attraction is diminished by their increased distance. It is sometimes said that the particles of a gas have no attraction for each other, but are, on the contrary, mutually repulsive. The expansive power of gases depends, however, on the presence of heat. It bears a strict relation to the quantity of heat, and most substances exist either in the solid, the liquid, or the gaseous state, according to the temperature to which they are subjected.

A body that is falling, or sliding down hill, by the effect of gravitation, gathers force in its descent, and may communicate a similar motion to other bodies with which it

* See *Med. Gaz.* vol. xlviii. p. 1092 ; and *Comptes Rendus*, t. xxx. p. 52.

† *Quarterly Journal of Science*, 1829, Part II., p. 354.

comes in contact if they are ill supported. In like manner, one of the most striking phenomena of the attraction at insensible distances is, that the changes or actions to which it gives rise are often a cause of their own continuance and extension.* This is more especially the case in living beings, but obtains to a great extent in the most simple processes of combination and decomposition. Thus ordinary combustion, from whatever cause it may arise, will usually continue as long as there is a supply of fuel and of air. We can explain the cause of this by saying that the fresh materials become heated by the combustion to a certain degree of temperature which causes ignition. But in other molecular changes which contain the cause of their own propagation, such as the various kinds of fermentation and putrefaction,† we have no instrument, like the thermometer, with which we can measure the force that communicates the change to substances in contact with those in which it is taking place.

Combustion, putrefaction, and numerous other molecular actions, although capable of self propagation, commence anew, under the requisite circumstances, without any contact with matter undergoing the same change. There are, however, changes of a more complicated nature—those to which plants and animals owe their development and continuance—that have never commenced anew within the experience of man. The most characteristic property, indeed, of vital actions probably is, that they are always caused by similar processes which have preceded them, whilst all other molecular changes may arise, occasionally at least, from other causes. A species of plant or animal consists, in fact, of a number or collection

* See Liebig's *Agricultural Chemistry*, 2nd ed. p. 258.

† The self propagation of the process of decomposition in the urine is a subject of great importance in a medical and surgical point of view. See a paper on alkalescent urine and phosphatic urinary calculi, *Med. Gaz.* Nov. 20, 1846.

of continuous molecular actions. The process of change may, as in certain insects and plants, be suspended for a time on account of the deficiency of warmth, of moisture, or of oxygen, but, when it recommences, it is in precisely the materials in which it left off. The vital actions, in these instances, admit of a pause, but the continuity by contact of material is uninterrupted. To borrow an illustration from ancient mythology, it is as if there were a pause in the spinning of the thread of life without its being cut or broken.

The same kind of temporary suspension may occur in continuous changes which are not vital. For instance, if a seam of coal is on fire at a great depth from the surface, the combustion can be entirely arrested by cutting off the access of air ; but, if no means are taken to cool the lately burning materials, they may remain for months at a bright red heat, ready to enter again on the process of combustion should air be accidentally admitted.

In the seeds of plants, and the ova of many animals, the molecular changes are capable of being suspended, and of recommencing after an indefinite period ; but they start again at the exact point at which they ceased, and should the matter of the seed or egg have deviated into any foreign change, such as putrefaction, it is incapable of continuing the process in which it had previously been taking part.

There is no distinct line of demarcation between vital processes and those which are not vital. Vinous fermentation, for instance, has been generally looked upon as a merely chemical change ; yet it has great claims to be entitled a vital process. It is always accompanied by the formation of the cells or sporules of the yeast fungus—the decomposition of the sugar into alcohol and carbonic acid bearing a direct relation to the quantity of yeast

produced.* Many persons would doubtless say that the formation of the sporules is a vital process, and the production of alcohol and carbonic acid a chemical process inseparable from it. According to this view, whilst cell development is undoubtedly a vital process,† digestion and the formation of compounds to be secreted or excreted are chemical processes. There is no objection to such a distribution of terms, but it must be remembered that the decomposition of sugar into alcohol and carbonic acid is as closely connected with a process of organization as are the sensibility and contractility of animal tissues. This blending together of what we call vital and what we call chemical, need not surprise us, however, when we consider that all changes of composition, with their attendant phenomena, whether taking place within the living body or not, are alike the result of the attraction or affinity which exists amongst the ultimate atoms or molecules of matter.

The quantity of matter in which any molecular change or group of changes is taking place, may diminish to a very

* See Schleiden's *Principles of Scientific Botany*, translated by Dr. Lankester, p. 36; and Liebig's *Agricultural Chemistry*, 2nd ed. p. 282.

Schleiden is of opinion that the yeast cells originate without the influence of a living plant. If it be so, their formation may be looked on as a natural link between the non-vital and the vital—between ordinary chemistry and physiology. The words of Schleiden are: "At a certain temperature, which is perhaps necessary to the chemical activity of the mucus, there originates, without as it appears the influence of a living plant, a process of cell-formation (the origin of the so-called fermentation fungus), and it appears that it is only the vegetation of these cells which produces the peculiar changes that occur in the fluid."

† Schleiden, however, speaking of vegetable cells, says,—“If further we regard the easy transformation of the assimilated matters, and may, from artificially conducted experiments, draw the conclusion that the nitrogenous matter which I have called mucus, and which forms the cyto-blast, is the substance which calls forth these transformations; and if we further remark that sugar and dextrine are more easily soluble than jelly, and that sugar and gum are changed into jelly, if the quantity of water is not increased, and which must be necessarily precipitated, we must regard the whole process of cell-formation as simply a chemical act. The gathering together of granules of mucus to form a cyto-blast we can as little explain as that, when we form a solution of two salts, if we throw into the mixture a crystal of one or other salt, that salt alone crystallizes around it.”—*Opus cit.* p. 35.

small amount without the continuity of action being broken. A conflagration may diminish to a spark, and yet spread again to as great an extent as before. A species might diminish to one or two individuals without becoming extinct; and, at the point at which new individuals commence, the molecular actions are often confined to a minute quantity of substance. There is reason to believe, however, that this substance contains all the chief elementary and proximate principles of the mature being, as well as the power of communicating all those changes to suitable materials, by which they are assimilated, and made to form part of the individual. The ova of animals have seldom been subjected to analysis, but seeds are known generally to possess the medicinal principles of the plants to which they belong, in more regular quantity than other parts of the plant.

Procreation by sexes, which is the most usual mode of generation throughout both the vegetable and animal kingdoms, appears to have the effect of preventing deviations from the form and character of the species; for gardeners are enabled, by means of cuttings, shoots, bulbs and tubers, to propagate many cultivated varieties of plants which differ greatly from the species to which they belong, and would soon revert to it if able and permitted to propagate by the sexual method, that is by seeds.

As organized beings rise in the scale of complexity, the points of connection between the individuals of one generation and those of the next increase in number and extent. In the lower classes of invertebrated animals a single germ yolk serves for the production of numerous individuals, and in some cases for the production of several generations; but in the higher invertebrata, and in all the classes of vertebrated animals, "only a single individual is propagated from each impregnated ovum."*

* Owen on Parthenogenesis, p. 62.

As we ascend through fishes and reptiles to birds, the number of the ova diminish and their relative size increases, till in some reptiles, and in all birds, the ovum, with its attendant yelk and albumen, is sufficient for the development of a nearly perfect animal, which undergoes all its metamorphoses before it has escaped from the shell, or obtained any nourishment beyond that contained in the egg.

In the class mammalia, with the exception of the marsupial order, the embryo becomes rooted, by means of the placenta, in the uterus of its mother, from whom it thus derives the materials for its development and growth, up to the period of its birth. The young of all mammiferous animals are also supplied by the mother, for a considerable period after birth, with nourishment secreted from her own blood ; and medical men have ample experience, as regards their own species, how much the prospect of health and life is diminished by the deprivation of this natural supply of nutriment.

In many birds and mammals there is a further connection between one generation and the next, in the way of teaching the young, to a limited extent, how to procure food and escape danger. In the human species, enjoying the faculty of speech, this connection between succeeding generations is much more intimate. Even among the Indians the boy is made to imitate all the actions of the man ; and in civilized countries, education, aided by literature, is generally much more complex and prolonged. In our own profession it has been truly said to last to the end of life, and institutions like this Society have the effect, not only of preserving and transmitting the knowledge of one generation of medical men to the next, but of increasing the boundaries of the science they cultivate, and rendering it more perfect and useful.

The communication of certain molecular changes tak-

ing place in the brain is by no means confined to the connection between parents and offspring, but extends collaterally in all directions, by means of vibrations in the air, or in the ethereal medium which pervades space. If the brain of an animal is in a particular state of molecular action, from any object that excites fear or joy, it may cause a similar state of the brain in others of its species, by uttering a cry, or merely assuming a particular demeanour. The faculty of speech gives to man a power of communicating his complex feelings and ideas, far exceeding that of the lower animals ; and the invention of literature has greatly increased this power in civilized nations. By speech, not only can fresh sensations and ideas be communicated, but also that continuation of them called remembrance, by which they revive after, it may be, a long interval of suspended action. By the aid of literature, indeed, knowledge committed to writing may lie dormant for centuries, like the ears of wheat in the hand of the Egyptian mummy, and then again take up the process of growth, to increase and spread in another part of the world.

In addition to the series of continuous molecular changes having for their result the preservation of the individual and the species, there are others, occurring in living beings, which have an opposite tendency ; they divert part of the substance of the individual from the actions which are natural to the species to another kind of action, in consequence of which this substance is employed in the multiplication and increase of the *materies morbi* of communicable diseases—an extensive group of maladies, each case of which is caused by some material that, as a general rule, has been produced in the system of another individual. The origin of these diseases, for aught we can tell, may be as remote as that of the beings they infest and exist on.

The communicable diseases—I use this term in pref-

erence to contagious, for various reasons*—the communicable diseases, to which the human species is liable, are chiefly as follow :—syphilis, small-pox, measles, scarlet-fever, typhus, typhoid and relapsing fevers, erysipelas, yellow-fever, plague, cholera, dysentery, influenza, hooping-cough, mumps, scabies, and the entozoa. Some persons do not admit the whole of the above diseases to be communicable, and, on the other hand, the Registrar-General includes acute rheumatism, and scurvy, in his class of zymotic diseases, although there is no evidence that these complaints are communicable. However, we have not been informed by the Registrar-General or Mr. Farr whether they wish the term zymotic to be understood in its true sense, which, as referring to diseases, signifies that they are communicable or contagious ; for yeast and other fermenting materials communicate, to substances capable of undergoing fermentation, a state of change similar to that by which they themselves have been produced.

The material cause of every communicable disease resembles a species of living being in this, that both one and the other depend on, and in fact consist of, a series of continuous molecular changes, occurring in suitable materials. The organized matter, as we must presume it to be, which induces the symptoms of a communicated disease, except in the case of the entozoa, can hardly ever be separately distinguished, like the individuals of a species of plant or animal ; but we know that this organized matter possesses one great characteristic of plants and animals—that of increasing and multiplying its own kind.† In the

* The word contagious is employed in a very different manner by different authors, and it could scarcely be employed, if any regard were paid to its etymology, to express some of the indirect modes of the communication of disease alluded to in the following pages.

† See a paper by Mr. Grove, of Wandsworth, *Med. Times*, vol. xxiv. p. 640.

instances of syphilis, small-pox, and vaccinia, we have physical proof of this increase, and in other diseases the evidence is not less conclusive.

The molecular changes taking place in the *materies morbi* of some diseases resemble the changes in many living beings in another respect also : they permit of being suspended, under certain circumstances, and recommence at the point at which they ceased. Thus the matter of variola and of vaccinia can be carried, in the dry state, to distant parts of the world without injury, like the seeds of a plant.

No evident effects are produced at first by the reception of the material cause of any of these diseases. There is always a definite period, of longer or shorter duration, before the illness commences, which is called the period of incubation. As regards the *materies morbi* itself, this a period of something more than incubation ; it is a period of reproduction. All substances capable of causing a disturbance in the animal functions produce symptoms from the moment of their absorption or imbibition, when introduced in sufficient quantity ; but the specific animal poisons, as they are called, are very rarely, if ever, introduced in such quantity as to produce sensible effects ; the disturbance in the system, which constitutes the diseases they induce, being due to the crop or progeny of the matter first introduced.

One character of communicable diseases is, that they are apt to be extremely prevalent at particular times and places. This character, which arises strictly out of their communication from individual to individual, has obtained for many of these diseases the name of epidemics—a name which may be applied to nearly all of them, although some are prevented, under ordinary circumstances, from showing their epidemic character. Thus syphilis, for instance, keeps a pretty even course in this metropolis, because there

is a steady amount of vice for its support, and a still greater amount of virtue to keep it in check ; but when it is introduced amongst a community of savages, indulging in promiscuous intercourse, it rages as a fearful epidemic. The extent of population and of intercourse has great influence over the epidemic character of communicable diseases. The various irruptive fevers are constantly present in London, and are only liable to fluctuations in their prevalence. In less populous districts, however, there are not enough subjects to support their constant presence. One or other of them is often absent for a number of years, and, when re-introduced, spreads to a great extent. There is one disease which neither the metropolis, nor the country at large, nor even the whole of Europe, will supply with victims except for a time. The cholera has been twice spread over the world within the memory of the present generation, and seems to be dying out a second time everywhere but in the south of Asia. Fatal as it is to the human species, it is itself so difficult of support that the world seems scarcely large enough for it, and, were it not for its pastures in India, it would be in danger of passing altogether out of existence, like the dodo of the Mauritius.

So far as can be learnt from what remains of ancient medical literature, the communication of diseases was not generally recognised till a recent period. Even Sydenham did not recognise the communicability of any acute febrile disease except the plague. He did not even recognise the communicability of small-pox. Sydenham, however, was fully aware of the resemblance between the material cause of an epidemic disease and a species of animal or plant, but he was not aware that animals and plants proceed only from procreation by their own kind ; and this is probably the reason why the communication of most diseases was unknown to him. Natural history was but

little cultivated in his day ; and he thought that plants, some of them not of the lowest classes, could be produced by other causes than generation. In the preface to the *History and Cure of Acute Diseases*, he says :—" Every specific disease arises from some specific exaltation, or peculiar quality of some humour contained in a living body." And again :—" For as every plant or animal is possessed of peculiar properties, so is it likewise in every exaltation of any humour after its being come to a species or disease. We have a clear proof of this every day," he continues, " in those kinds of excrescences that grow on trees and shrubs (occasioned by the ill quality of the nutritious juice, or other causes), in the form of moss, mistletoe, mushrooms, and the like, all of which are manifestly different essences, or species from the tree or shrub that bears them."

For want of knowing any other cause, epidemics were attributed, by the ancients, to the atmosphere, without any evidence ; just as political and social events were believed to be occasioned by the stars. Now as people are not only exposed to the atmosphere, as soldiers in battle are to bullets, but are actually immersed in it, as fishes are in the sea, it became necessary to explain why certain persons were attacked and others not attacked, and the word *predisposition* was used as affording an explanation. The alleged predisposition, however, was nothing visible or evident : like the elephant, which supports the world, according to Hindoo mythology, it was merely invented to remove a difficulty.

As the composition and physical properties of the air began to be better understood, it became evident that the atmospheric hypothesis of epidemics did not explain their phenomena, even with the assumption of a predisposition existing in some persons and not in others. It is not possible, for instance, that a disease caused by anything

in the general atmosphere should progress in opposition to the wind, or should remain for weeks in a place before extending to the next parish on either side. There are still, however, some persons, especially amongst the general public, who lean towards the atmospheric origin of epidemic diseases ; and, when Professor Schönbein lately considered that he had discovered a new gaseous substance in the air, which he named ozone, it was straightway supposed that this was the cause of cholera. After a little time, as the supposed ozone was found to be pretty generally present, cholera and some other diseases were attributed to its absence. Of course either the presence or absence of azone, along with a presumed predisposition, would afford a perfectly satisfactory explanation of cholera, or any other disease, to all those who do not require any proof.

It is quite possible, and, indeed, almost certain, that the material cause of some communicable diseases may be wafted a short distance through the air, like the seeds and spores of many plants. The matter of small-pox pustules, for example, retains its powers after being dried, and may be shaken from articles of clothing, and thus wafted through the air. This is probably true of other diseases. It is, however, only a mode of communication of the disorders in question, and would not warrant us in speaking of their atmospheric origin, any more than of the atmospheric origin of plants.

When the communication of diseases began to be recognised, it was thought to depend, in most cases, on effluvia given off from the patient into the surrounding air : even syphilis, for some time after its appearance in Europe, was believed to be propagated in this way, and persons suffering from it were driven out of the towns and villages to live or die in the fields, lest they should infect others with their breath, although the disease was

not attributed to any misconduct on their part.* Now as effluvia of any kind must reach all who approach the patient, the idea of a predisposition existing in some persons and not in others, has been retained to explain why certain individuals only are attacked with the diseases. We are informed by M. Ricord and others that when the pus from a chancre, in its active or increasing stage, is introduced by inoculation, it never fails to communicate the disease. The matter of small-pox pustules hardly ever failed, when inoculation was practised, to cause the complaint in those who had not had it already ; and vaccination does not fail more than once in several hundred times, when properly performed. So far, therefore, as we have analogy to guide us, we are warranted in concluding that when the morbid matter of any disease is received into the system, in the way required in that particular disease, it is almost certain to produce its specific effects, except in the instances in which the patient has gained an immunity by a former attack. Consequently, until it can be shown that the *materies morbi* of any communicable disease has really entered the economy of those who do not take the malady, there is no reason to invoke a supposed predisposition, or predisposing causes, to account for its existence in the persons in whom we find it. To be of the human species, and to receive the morbid poison in a suitable manner, is most likely all that is required.†

Climate and season have a certain effect in favouring or preventing many epidemic diseases. Yellow fever has not yet been known to propagate itself to any extent in high latitudes. The plague, when it visited countries

* Astruc, lib. i. ch. iv.

† I do not deny that the period of life, being ill or well nourished, and other evident conditions of the patient, influence his liability to certain epidemic diseases. The predisposition objected to above is that which is assumed, without any symptoms of its existence, merely from the fact of the patient taking the disease.

with a temperate climate, prevailed chiefly in the summer, and this has also been the general rule with Asiatic cholera, although, at Moscow and in Scotland, it has been most severe in the winter, on both occasions of its visiting Europe. The influence of climate and season have, however, been much overestimated, having been even accused of causing epidemics. We constantly, also, hear climates called healthy or unhealthy; which is as incorrect as it would be to call them fruitful or barren. California, for instance, was proverbial for the healthiness of those who resided there, and this healthiness was attributed to its climate. No sooner, however, was the discovery of gold made, than the cholera was conveyed across the mountains, by crowds of people, who left the route strewn with the dead bodies of those who died on the journey. Dysentery and other diseases began to prevail amongst the diggers, and the medical men found plenty of employment; although it cannot be supposed that a few hundred people, scratching here and there for gold, had altered the climate of the country.

Certain localities are favourable to the communication of particular epidemic diseases, whilst others are unfavourable; for instance, in this metropolis, the low-lying districts on the south of the Thames have proved more favourable to the propagation of plague and cholera than the more elevated districts on the north. Yellow fever and dysentery are also most prevalent in the low and marshy parts of hot countries. Such situations are sometimes said to be productive of diseases; but this expression is obviously incorrect, when applied to those disorders which are communicable from person to person, either directly or indirectly.

There is one class of diseases—intermittent fevers—which are so fixed to particular places that they have deservedly obtained the name of endemics. They spread

occasionally, however, much beyond their ordinary localities, and become epidemic. Intermittent fevers are undoubtedly often connected with a marshy state of the soil ; for draining the land frequently causes their disappearance. They sometimes, however, exist as endemics, where there is no marshy land or stagnant water within scores of miles. Towards the end of the seventeenth century, intermittent fevers were, for the first time, attributed by Lancisi to noxious effluvia arising from marshes. These supposed effluvia, or marsh miasmata, as they were afterwards called, were thought to arise from decomposing vegetable and animal matter ; but, as intermittent fevers have prevailed in many places where there was no decomposing vegetable or animal matter, this opinion has been given up in a great measure ; still the belief in miasmata or malaria of some kind, as a cause of intermittents, is very general. It must be acknowledged, however, that there is no direct proof of the existence of malaria or miasmata, much less of their nature. Intermittent fevers were attributed to such agents from the absence of any other known cause, especially as they were observed to come on after exposure to the air of certain localities, more particularly at night.

There is, however, some evidence of another and different cause of intermittent fevers than that above alluded to. In the "General Report of the Poor Law Commissioners on the Sanitary Condition of Great Britain,"* Mr. Wm. Blower, Surgeon, of Bedford, states that typhus and ague, which had long infested the village of Wootton, near Bedford, had been much diminished by digging a few wells, and obtaining good water. He also states that, in the neighbouring parish of Houghton, almost the only family which escaped ague, at one time, was that of a respectable farmer who used well water, whilst all the other families had only ditch water.

* 8vo. 1842, p. 66.

M. Boudin* relates a very marked instance in which intermittent, and apparently also remittent, fever were caused by drinking marsh water. It is as follows :—

“ In July, 1834, 800 soldiers, all in good health, embarked on the same day in three transports at Bona, in Algeria, and arrived together at Marseilles; they were exposed to the same atmospheric influences, and were, with one essential difference, supplied with the same food, and subjected to the same discipline. On board one of the vessels were 120 soldiers: of these, 13 died on the passage, from a destructive fever, and 98 more were taken to the military hospital of the lazaretto at Marseilles, presenting all the pathological characters proper to marshy localities. On seeing the physiognomy of these patients, altogether so unusual for Marseilles, one would have said that the Gulf of Mexico, the Delta of the Ganges, and the marshes of Senegal and of Holland, had supplied passengers to this ship. In short, by the side of a simple intermittent, there was a pernicious fever. On an inquiry being instituted, it was ascertained that on board the affected ship the water supplied for the soldiers, owing to the haste of the embarkation, had been taken from a marshy place near Bona; whilst the crew, not one of whom was attacked, were supplied with wholesome water. It further appeared that the nine soldiers who escaped had purchased water of the crew, and had consequently not drunk the marshy water. Not a single soldier or sailor of the other two transports, who were supplied with pure water, suffered.”

Mr. Grainger, who quotes the above circumstance in his Appendix to the Report on Cholera, also says,† “ Dr. Evans, of Bedford, related to me an equally well-marked instance. A few years ago, he was staying at Versailles, with his lady, when they both became affected with the

* Essai de Géographie Médicale, p. 53.

† Page 94.

ague, and, on inquiry, the following facts were disclosed. The town of Versailles is supplied with water for domestic purposes from the Seine, at Marli. At the time in question, a large tank, supplying one particular quarter, was damaged, and the mayor, without consulting the medical authorities, provided a supply of water, consisting of the surface-drainage of the surrounding country, which is of a marshy character. The regular inhabitants would not use this polluted water ; but Dr. and Mrs. Evans, who were at an hotel, drank of it unwittingly, and it was also used by a regiment of cavalry. The result was, that those who drank the water suffered from intermittent fever of so severe a type, that seven or eight of the soldiers, fine young men, died on one day, September 1, 1845. On a careful investigation it was ascertained that those only of the troops who had drunk the marsh-water were attacked ; all the others, though breathing the same atmosphere, having escaped, as did also the townspeople.”

In all the instances I have just quoted, the cause of ague, whatever it may be, was swallowed with the water, not inhaled with the air ; and on questioning two patients, ill with this complaint, in St. George’s Hospital, after harvesting in Kent, they told me that they had often been obliged to drink water from the ditches. The disease of the liver and spleen, to which persons are subject after attacks of intermittent fever, also confirms the view that its material cause enters the system by the alimentary canal, and not by the lungs ; and it is of importance to remark, that Hippocrates observed, that drinking stagnating waters caused hard swellings of the spleen.*

Whether the unknown cause of ague has been produced in the system of a previous patient, like the pus of small-pox and the eggs of tape-worm, or whether it has been produced externally, there is, at present, no sufficient evi-

* De aere, aquis et locis.

dence to show. In the case first supposed, the disease would be a communicable one, in the second it would not.

There is one circumstance which seems to indicate that the specific cause of intermittent fevers undergoes a development or multiplication within the system of the patient,—it is, that a period of dormancy, or incubation, has been observed, in many cases, between the visit to the unhealthy locality and the illness which followed ; for, as I have already remarked, every poisonous or injurious substance causes symptoms as soon as it has been absorbed in sufficient quantity.

The communication of ague from person to person has not been observed, neither has that of tape-worm, although in this latter disease there is proof of communication that hardly any one disputes, viz. the evidence that the creature is only found in the bowels, and the general principle, “*omne vivum ex ovo.*” Supposing ague to be communicable, it may be so only indirectly, for the *materies morbi* eliminated from one patient may require to undergo a process of development or procreation out of the body before it enters another patient, like certain flukes infesting some of the lower animals, and procreating by alternate generations.

But, to return to those diseases which are known to be communicable, there are certain spots, more limited than the districts or localities previously mentioned, in which they find easy means of communication :—I allude to the courts and allies crowded with the poor. It happens that there is generally no lack of offensive gases or disagreeable smells in these spots. Now it is well known that the gases arising from decomposition cause no fevers or other epidemic diseases, when they are made artificially in the laboratory. The same is true when they occur more naturally in the dissecting room ; and it has also been proved that persons who get their living by working

amongst decaying animal and vegetable matters are not more liable to these diseases than other persons.* Still there are some medical men, and a benevolent section of the general public, who attribute the excess of epidemic disease, found in crowded and poor localities, to what are called noxious effluvia. They cannot say that these effluvia predispose to the diseases, for persons from the country are often attacked too soon after their arrival in such places to allow of this mode of action, and they do not inquire whether peculiar facilities may not exist for the conveyance of specific virus from one person to another, but they hold that the noxious effluvia, together, perhaps, with an undefined something in the general atmosphere, may cause or increase any epidemic disease whatever; and, when a nuisance is discovered, the prevalence of any kind of disease at the place is said to be explained, although we are not told how. The gentlemen who hold these popular opinions do not seem to recognise specific causes of disease. They are, with respect to diseases, in the position that some of our ancestors were in with respect to plants and animals, when they believed in spontaneous or equivocal generation, and thought that dirt engendered vermin, and that mushrooms arose from horse-dung.

Nothing assists the communication of disease more than the want of personal cleanliness. This has been particularly observed in regard to plague, cholera, yellow fever, and continued fevers. There is one class of people who have no provision for cleanliness whatever—namely, the vagrants,—and they are notorious for contracting fevers, and carrying them about from place to place. It is the same with regard to cholera, when that disease prevails; and these people nearly always have the itch. Amongst the poor, who are less unfortunately situated,

* See Bancroft on Yellow Fever.

there is often very little cleanliness, and, when a number of persons reside, sleep, and eat in a small room, in which also the cooking is conducted, it is extremely difficult, when an individual is confined to bed by illness, to prevent his excretions being partaken of by all the inmates ; indeed, with the uncleanly habits of many of the poor, this is altogether impossible. Under these circumstances we find that, when typhoid fever or cholera enters such a dwelling, it is very apt to go through the house, as the phrase is. It often attacks the friends also, who visit and eat and drink with the inmates, whilst the medical and clerical visitors escape. But when cholera or typhoid fever occurs in cleanly families, where the nursing, the cooking, the sleeping, and the eating go on in separate apartments, it is hardly ever found to spread.

It is not improbable that the specific cause of influenza and measles is drawn in with the breath, as these diseases affect chiefly the respiratory organs, and spread almost equally amongst all classes of the community ; but the great aid that want of personal cleanliness lends to the extension of many communicable diseases points to another mode of communication ; namely, that by swallowing the morbid material. It has been said that animal poisons do not act when taken into the stomach ; but this is incorrect, for cantharides, the sausage and bacon poisons, and others, act when taken in this manner ; and it should also be remembered that the virus of a specific disease is not strictly a poison, in the sense of that of the viper, for it is capable and requires to be multiplied in the system, before its effects appear.

There is evidence tending to show that typhoid fever, yellow fever, and plague, as well as cholera, are communicated by accidentally swallowing the morbid excretions of the patients, and that these latter may sometimes be conveyed to a distance with the drinking water, or other

articles of diet, without losing their specific properties.* Thus the communication of these diseases may be more or less direct or indirect, even when it takes place virtually in the same manner. The first authenticated case of cholera which occurred in London in the autumn of 1848, was that of John Harnold, a seaman of the steam ship *Elbe*, newly arrived from *Hamburgh*, where the disease was prevailing. He died in a lodging at *Horsleydown*, near the river. The next case was that of a man who came to lodge in the same room ; and a few hours afterwards cases occurred in *Lower Fore Street*, *Lambeth*, and in *White Hart Court*, *Chelsea*, amongst people who had no water for drinking or any other purpose, except what was obtained by dipping a pail into the *Thames*. Thus the cholera poison from John Harnold appeared to be distributed like the seeds of a river-side plant, some of which germinate and grow up by the side of their parent, whilst others are conveyed some distance by the tide, and take root on another part of the shore.

Those sudden extensions of cholera, which are called outbreaks, were in many cases due to the mixture of the cholera-evacuations with the water used for drinking and preparing food. This was shown to be the case in the *Wandsworth Road*, in *Bermondsey*, and in *Rotherhithe*, during the summer of 1849.† It has been often argued that sudden outbreaks of cholera are incompatible with its propagation from person to person, but we know of no circumstances to restrict the number of persons who may receive the disease from one or two patients, under favour-

* Dr. Jenner lately called my attention to an instance occurring at the village of *North Boston*, *Erie County*, *N. Y.*, in which typhoid fever was probably communicated to a number of families by the contamination of the water of a well which they used. See *Clinical Reports of Continued Fever*, by *Austin Flint*, M.D., *Buffalo*, 1852, p. 380 ; also, *Med. Times and Gazette*, March 12, 1853, p. 261.

† *Snow on the Mode of Communication of Cholera*, p. 12 ; *Med. Gaz.* vol. xlv., p. 747 ; *Med. Times*, vol. xxiv., p. 561.

able circumstances for the distribution of the morbid matter. There were a few cases of cholera present at Kurrachee, previous to the outbreak of the disease in 1846, which has been often alluded to ; so that, like the outbreaks in England, it was in reality but an extension of the malady.*

Medical men are naturally apt to form their opinions respecting the communication of diseases from their own experience, rather than from the general history of the maladies, and thus they believe in its contagion, when a disease, such as cholera or typhoid fever, generally spreads directly from person to person in their practice ; but in districts or connections in which the indirect and less obvious mode of contracting disease is, from physical causes, the prevailing one, they are apt to become what are called non-contagionists.

It may very fairly be asked whether communicable diseases do not sometimes arise spontaneously—that is, from other causes than their communication, just as ordinary combustion, putrefaction, and some other continuous molecular changes, very often commence anew, from various causes, without any continuity with previous changes of the same kind, and it is not improbable that some communicable diseases may arise, so to say, spontaneously. The erysipelatous inflammation, for instance, which attacks the neighbourhood of wounds, probably arises now and then without being communicated ; otherwise we must

* The following table from p. 2 of Mr. Alex. Thom's Report of the Cholera at Kurrachee shows the progress of the outbreak :—

Dates.	Admissions.							Deaths.
June 11	-	-	-	1	-	-	-	1
„ 12	-	-	-	2	-	-	-	—
„ 13	-	-	-	2	-	-	-	—
„ 14	-	-	-	1	-	-	-	1
„ 15	-	-	-	47	-	-	-	8
„ 16	-	-	-	105	-	-	-	70
„ 17	-	-	-	104	-	-	-	53
„ 18	-	-	-	47	-	-	-	32

suppose the material which causes it to be almost as widely diffused as the spores of some of the fungi. There is, however, great reason to believe that the larger number of communicable diseases never arise from any other cause than the communication of the specific virus from a previous patient. Dr. Watson has given very strong proofs of this, in regard to small-pox, in his lectures, and proofs almost as strong might be adduced in respect to other diseases. We know very well from history that the plague spreads fearfully in this country, when it is imported, and, if it ever arises spontaneously, why should we have been without a case of it for nearly two centuries? We sometimes hear it asked, "Then how did the first case arise?" The question might as well be asked with respect to the first tiger or the first upas tree; but our ignorance of the first origin of natural phenomena need be no obstacle to the investigation of their present causes.

I have just said that some communicable diseases, such as erysipelatous inflammation, may possibly arise, now and then, without contagion; but there is an opinion held by some men of eminence to which it is very difficult to assent:—I allude to the doctrine that a disease caused by malaria, which is supposed to be produced out of doors, without any regard to a previous patient—that such a disease can, under certain circumstances, take on contagious properties. For instance, many persons believe that yellow fever, as it occurs, for example, on the western coast of Africa, is caused by malaria or marsh miasmata; and when they have been convinced by such facts as those adduced by Dr. M'William respecting Boa Vista, that this fever is communicated from person to person at another place, instead of reviewing their previous opinion, they try to reconcile it with the new conviction, by supposing that the disease has taken on contagious properties which it did not previously possess. Now this amounts to nothing

more or less than supposing that some material produced in marshy ground, without any connection with the human body, can be reproduced and grow in the system of the patient. I believe we know nothing in nature analogous to this, and it is therefore an opinion which should not be adopted till there is strong evidence in its support. It is most likely that yellow fever was always a communicable disease.

With respect to preventing the communication of disease, it is worthy of remark that there are two diseases whose mode of propagation is well known to almost everybody, and almost everybody has it in his power to avoid them—I allude to syphilis and the itch. It will perhaps one day be seen whether other communicable diseases may not be as easily avoided, when their mode of communication is known. In the meantime it is very well ascertained that cleanliness is a great protection against many of them, as are also space, daylight, and ventilation. The cleanliness which, it may be observed, cannot be attained without sufficient space and daylight, should not be a cleanliness for mere appearances ; it should be a rational cleanliness, like that by which the chemist keeps his tests pure and distinct, and the farmer his land free from weeds. There should be not only personal cleanliness, but cleanliness in every department of the household—cleanliness in builders and owners of house property, to deter them from sinking wells so near to cesspools and drains, that their contents may percolate without proper filtration—cleanliness in water companies, to prevent them from sending water containing sewage to their customers, as was done on the south side of the Thames till very lately—and cleanliness in sanitary reformers, to deter them, in their fear of offensive effluvia, from abolishing cesspools and having the sewers flushed, and thus sending all the recent excrementitious matters into the rivers, until they have ascertained

that people are no longer obliged to drink the water of these rivers.

Some great improvements have been made lately in the way of cleanliness. The model lodging-houses are instances of this kind, and so are the public wash-houses, which enable poor persons to wash the foul linen of a sick person without being obliged to do it amidst the plates and tea-cups, the bread and meat, and other provisions of the family.

The prevention of epidemic or communicable diseases is a subject which deserves increased investigation. These diseases influence the life, the death, and the numbers of the human race, more than all other causes. The very learned physician Dr. Gordon Latham is of opinion that the downfall of the Roman Empire was due as much to several severe epidemics as to any other cause; and although I am far from apprehending any such calamity now, as “a speedy return of the middle ages,” there are circumstances occurring which deserve our vigilance. The increased and more rapid traffic between nearly all parts of the world, especially that by means of large steam-ships, renders it probable that diseases, hitherto confined to particular divisions of the globe, may gain a wider range, and thus increase the number of diseases in nearly every country. For now, when the commercial interest and influence preponderate over every other, the day is gone by for strict quarantine, which, indeed, was ever but a doubtful measure, as it was liable to evasion, and could not be enforced on the smuggler.

The question of contagion in various diseases has often been discussed with a degree of acrimony that is unusual in medical or other scientific inquiries. The cause of the warmth of feeling that has been displayed has, in most cases, probably been unknown to the disputants. It is the great pecuniary interests involved in the question, on

account of its connection with quarantine. In the preface to his work on the Plague of Aleppo, Dr. Russell says,—

“ But however indisputable the fact of the plague being contagious may be deemed by modern physicians, it may be remarked that it has been strongly opposed, as often as the subject of quarantine has fallen under the deliberation of the legislature ; and the public, at such times, have been constantly pestered by an inundation of pamphlets, which, without advancing anything new, merely retailed arguments which had long before been refuted.”

Since 1791, when the above was written, the commerce of this country has increased a hundred-fold, and for every ten thousand pounds that were jeopardised by quarantine then, a million is in danger now.

The chief arguments against the communication of disease have been shaped according to the belief that, if communicated at all, it must be by contact with the patient, or by effluvia from his person, clothing, or bedding. The communication of disease by accidentally swallowing morbid excretions, to which attention has more particularly been called of late, considerably alters the ground of debate ; but if the doctrine of the communication of disease must involve quarantine, it will always be very unpopular, and its advocacy extremely unpleasant to the medical man, however conclusive the proofs of it may be. This of itself is a reason for endeavouring to ascertain how far communicable diseases of all kinds can be prevented by measures of detail which do not interfere with commerce.

The mode of propagation and the means of prevention of epidemic diseases require, as I said, increased investigation ; and if any inducements were wanted to stimulate my present audience to that inquiry, it would only be necessary to remind you that, by investigating one of these diseases, a former Fellow of this Society was enabled to make the greatest discovery that has ever been made in

the practice of medicine, and to render the greatest benefit to his species which they have probably ever received. I need hardly say that I refer to Jenner.

THE END.

APPENDIX

APPENDIX.

I. CHOLERA AND THE WATER SUPPLY: LATER PAPERS

WHEN SNOW made his study of cholera mortality as related to the two principal water supplies in the South Districts of London, he had information on the total number of houses supplied by each company but no exact information as to the number of houses supplied in each sub-district. Therefore, while he was able to ascertain the number of deaths from cholera in the consumers of each water supply in each sub-district and to show that quite uniformly the number of deaths was greater among the consumers of the Southwark and Vauxhall than of the Lambeth supply, he was not able to calculate actual mortality rates in the two groups by sub-districts. However, shortly after the results of his study were made known the General Board of Health undertook an official inquiry which eventually supplied the detailed statistics of population which Snow had lacked.

Lists of the houses receiving water from the Southwark and Vauxhall and the Lambeth water companies, respectively, were obtained from the companies, and compared in detail with the records of deaths on file in the General Register Office. The report on this inquiry, prepared by John Simon, was published in May, 1856. Without alluding in any way to Snow, the report confirmed his findings by the conclusion that, in the epidemic of 1853-54: "The population drinking dirty water accordingly appears to have suffered 3.5 times as much mortality [from cholera] as the population drinking [other water]." Tables were appended giving, for each district and sub-district, the number of houses and the estimated population supplied by the two water companies, and the deaths therein.

In a paper on "Cholera and the water supply in the South

Districts of London in 1854," published in the October, 1856, issue of the *Journal of Public Health*, Snow extends his previous discussion of the subject, using the detailed population statistics given in Simon's report. After giving a full but succinct outline of his studies as previously published, he proceeds:

The results of my inquiry into the supply of water were, of course, obtained separately for each district and subdistrict in which the inquiry was made, and were so published ; but I was unable at the time to show the relation between the supply of houses in which fatal attacks took place, and the entire supply of each district and subdistrict, on account of the latter circumstance not being known. I expressed myself as follows in an article which I published soon after my inquiry was made : " I hope shortly to learn the number of houses in each subdistrict supplied by each of the water companies respectively, when the effect of the impure water in propagating cholera will be shown in a very striking manner, and with great detail."* This information did not, however, come within my reach till recently, and not even then with all the accuracy I could desire. In the Report on the Cholera Epidemics of London as affected by the Consumption of Impure Water, lately written by Mr. Simon, and published by the General Board of Health, there is a statement of the number of houses supplied by each of the water companies respectively in each district and subdistrict. The line has not been very accurately drawn where a street, as often happens, is partly in one district and partly in another ; and thus, in the recent Report, the subdistricts of St. Saviour's, Southwark, Leather Market, Bermondsey, Battersea, and Peckham, have been represented to contain a few houses supplied by the Lambeth Company, although they do not contain any. With regard to Bermondsey, it is stated in a foot note that some ends of streets may have been included which have passed the registration boundary, and this has happened in other cases ; but the errors arising from this cause are limited in amount, and cannot much affect the statistical calculations that I have made. There is also a further imperfection in the account of the water supply of the subdistricts. The numbers which are stated to represent the houses supplied by each water company in each subdistrict are found on adding up the tables not to do so, but to represent the number of houses, minus those situated in streets in which no death occurred ; the latter being placed all together at the end of each group of subdistricts which constitutes a district. Streets vary in size from one or

* Medical Times and Gazette, October 7, 1854, p. 365.

two houses to two or three hundred, and the small streets would obviously be the most likely to be exempt from mortality ; it could, therefore, do little good to distinguish such streets ; however, if thought desirable, this could as well have been done by simply stating the number of the houses, without deducting them from the gross number in each subdistrict. The number of houses in these exempted streets is about one-ninth of the whole. Instead of being able to compare, as I could wish, the mortality in the houses supplied by each company with the exact number of houses supplied, I have only been able to compare it with the number of houses in the streets in which deaths occurred. This will necessarily raise the proportion of deaths about one-ninth ; but there is every reason to believe that the relative proportion of deaths in the population supplied by the two companies respectively, which is the real object of the inquiry, will remain almost unaltered.

As the first four weeks of the epidemic did not furnish a sufficient number of cases in all the subdistricts to serve for a statistical inquiry in detail, I have commenced by taking the first seven weeks of the epidemic collectively ; and the first of the tables which accompanies this paper exhibits the results of my personal inquiry, when placed in connexion with the number of persons and houses supplied in each subdistrict by each water company respectively. The reader will observe from the last division of the table that the proportion of deaths was, in every subdistrict, very much greater amongst the population supplied by the Southwark and Vauxhall Company than amongst that supplied by the Lambeth Company, and that the relative mortality is nearly the same throughout, except in two or three instances, where there were but one or two deaths for the basis of calculation amongst the customers of the Lambeth Company. The second table shows the results of that part of the inquiry, conducted by Mr. Whiting, treated in a similar manner. In the subdistricts here enumerated, which were supplied, except just on the border of three of them, exclusively by the Southwark and Vauxhall Company, the mortality will be observed to be nearly the same, only a little higher, than amongst the population supplied by the same company, and mixed with that supplied by the Lambeth Company, as shown in the previous table.

In a third table, he summarizes the data of Tables I and II by districts, and in Table IV he shows by districts the results of the inquiry as conducted by the General Register Office during the last ten weeks of the epidemic. As Tables III and IV are

included in Table V, they are omitted here. In presenting Table V, Snow states :

In the fifth table the numbers in the previous ones are added together, and fresh calculations made, so as to show the result of the inquiry for the whole epidemic. The instances in which the water supply was not specified, or not ascertained, in the returns made by the district registrars must evidently nearly all have been cases in which the house was supplied by one or other of the water companies, for, if the persons received no such supply, and obtained water from a pump well, canal, or ditch, there could be no difficulty in knowing the fact. Moreover, as the two water companies are guided by precisely the same regulations, the difficulty in ascertaining the supply is exactly the same with regard to one as the other ; I, therefore, concluded that I could not be wrong in dividing the non-ascertained cases between the two companies in the same proportion as those which were ascertained, and I have done so at the foot of Table V, in order to obtain a complete view of the influence of the water supply during the whole epidemic of 1854. These general results I have employed as the basis of some further calculations.

In a final table, not reproduced here, he calculates, for each subdistrict, for the whole period of seventeen weeks, the number of deaths which would result from applying to the consumers of each water supply the mortality rates (160 and 27 per 10,000, respectively) shown for each water-supply group as a whole in Table V. He notes that these hypothetical figures agree rather closely with the observed deaths in each subdistrict, except where the numbers are very small. This table is interesting, but not essential.

Discussing Table V, Snow expresses the belief that, because of duplication of house-numbers, it is impossible to allocate deaths correctly to their place of occurrence except by "personal inquiry, made on the spot, at the time" ; and is convinced that in the official inquiry many errors must have been made. He cites reasons why these would tend generally to increase the apparent mortality rate in consumers of the Lambeth water supply and to decrease it in consumers of the Southwark and Vauxhall supply. He considers that his Table V represents a much more exact allocation of deaths to water supply than does

TABLE I. Shewing the results of the Author's personal Inquiry in Twenty-One Sub-Districts.

Registration Districts.	Registration Sub-Districts.	Number of inhabited houses in 1851.	Population in 1851.	Estimated constant population per house.	“Number of houses, and estimated number of persons, supplied in 1854 with water as under.”				Water supply of the houses in which fatal attacks of cholera took place during first seven weeks of epidemic of 1854.					Deaths from cholera in first 7 weeks of epidemic of 1854.	Mortality per 10,000 supplied with water as under.	
					By Southwark and Vauxhall Co.		By the Lambeth Company.		Southwark and Vauxhall Co.	Lambeth Co.	Thames, canals, or ditches.	From pump-wells.	Supply not ascertained.		Southwark and Vauxhall Co.	Lambeth Co.
					No. of houses.	Estim. Population.	No. of houses.	Estim. Population.								
St. Saviour, Southw.	1. Christchurch.	1,887	16,022	8·5	343	2,915	1,557	13,234	11	13	0	0	1	25	37·7	9·9
St. George, Southw.	1. Kent Road.	2,558	18,126	7·1	1,779	12,630	563	3,997	52	5	0	0	0	57	41·1	12·5
	2. Borough Road.	2,069	15,862	7·7	1,176	8,937	878	6,672	61	7	0	0	3	71	68·2	10·4
	3. London Road.	2,365	17,836	7·5	383	2,872	1,533	11,497	21	8	0	0	0	29	73·1	6·9
Newington.	1. Trinity.	3,224	20,922	6·5	1,661	10,132	1,372	8,370	52	6	0	0	0	58	51·3	7·1
	2. St. Peter, Walworth.	4,925	29,861	6·1	2,340	14,274	1,758	10,724	84	4	0	0	2	90	58·8	3·7
	3. St. Mary.	2,309	14,033	6·1	489	2,983	899	5,484	19	1	0	1	0	21	64·5	1·8
Lambeth.	1. Waterloo, part 1.	1,729	14,088	8·1	438	3,548	1,474	11,939	9	1	0	0	0	10	25·6	0·8
	2. Waterloo, part 2.	2,191	18,348	8·4	864	7,171	1,510	12,533	25	8	2	1	0	36	34·8	6·3
	3. Lambeth church, pt. 1	2,451	18,409	7·5	415	3,113	2,117	15,878	6	9	1	0	2	18	19·2	5·6
	4. Lambeth church, pt. 2	3,849	26,784	7·0	1,124	7,868	2,289	16,023	34	13	0	1	5	53	42·9	8·1
	5. Kennington, part 1.	3,977	24,261	6·1	2,586	15,775	444	2,708	63	5	0	3	0	71	39·9	18·4
	6. Kennington, part 2.	3,288	18,848	5·7	1,206	7,874	986	5,620	34	3	0	1	0	38	43·2	5·7
	7. Brixton.	2,362	14,610	6·1	310	1,922	1,509	9,356	5	2	0	0	2	9	26·0	2·1
	8. Norwood.	600	3,977	6·6	0	0	160	1,066	0	2	5	1	0	8	..	18·7
Wandsworth	3. Wandsworth.	1,522	9,611	6·3	144	907	15	94	1	0	8	2	0	11	11·0	..
	4. Putney.	918	5,280	5·7	13	74	0	0	0	0	0	1	0	1	..	..
	5. Streatham.	1,419	9,023	6·4	0	0	515	3,244	0	1	0	5	0	6	..	3·0
Camberwell.	1. Dulwich.	259	1,632	6·3	0	0	4	25	0	0	0	0	0	0	..	..
	4. St. George.	2,845	15,849	5·6	767	4,295	971	5,437	30	9	0	2	1	42	69·8	16·5
Lewisham.	5. Sydenham.	801	4,501	5·6	0	0	unkno.	unkno.	0	1	0	2	1	4	..	..
Totals.		47,548	317,883	6·6	16,038	107,290	20,554	143,901	507	98	16	20	17	658	47·2	6·8

the official inquiry. He concludes that the relative mortality in the consumers of the two water supplies was actually in the ratio of about 6 to 1, as is shown in his table, rather than 3.5 to 1, as given in the official inquiry.

It is impossible to check the deaths in Snow's Table V against the tables given in Simon's report. The latter includes the whole epidemic period of 1853-54, while Snow's table refers to the seventeen weeks from July 9th to November 4th, 1854, during which time the sources of water supply in the houses where deaths occurred were ascertained by Snow himself, by Mr. Whiting, or by the local registrars. It appears, however, from comparison of Snow's data with those given in Simon's report, that Snow was justified in believing his to be more accurate.

Quite aside from this question, Tables I and II of this paper confirm, in detail, the inferences drawn from Table VIII of *The Mode of Communication of Cholera*.

W. H. F.

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(Letter to the Registrar General. . . by William Farr, quoting from the Weekly Returns of October 14 and December 3, 1854).

TABLE II.

Shewing the results of the Inquiry made by Mr. Whiting in Eleven Sub-Districts.

Registration Districts.	Registration Sub-Districts.	Number of inhabited houses in 1851.	Population in 1851.	Estimated constant population per house.	“Number of houses, and estimated number of persons, supplied in 1854 with water as under.”				Water supply of the houses in which fatal attacks of cholera took place during first seven weeks of epidemic of 1854.					Deaths from cholera in first 7 weeks of epidemic in 1854.	Mortality, per 10,000 supplied with water as under.	
					By Southwark and Vauxhall Co.		By the Lambeth Company.		Southwark and Vauxhall Co.	Lambeth Co.	Thames, canals, or ditches.	Pump-wells.	Supply not ascertained.		Southwark and Vauxhall Co.	Lambeth Co.
					No. of houses.	Estim. Population.	No. of houses.	Estim. Population.								
St. Saviour, Southw.	2. St. Saviour.....	2,713	19,709	7·3	2,238	16,337	123	898	115	0	10	0	0	125	70·3	Southwark and Vauxhall Co.
St. Olave, Southwark	1. St. Olave.....	880	8,015	9·1	961	8,745	0	0	43	0	5	0	5	53	49·1	
Bermondsey.....	2. St. John, Horselydown	1,480	11,360	7·7	1,170	9,360	0	0	48	0	3	0	0	51	50·1	Lambeth Co.
	1. St. James.....	2,863	18,899	6·6	3,511	23,173	105	693	102	0	21	0	0	123	44·0	
	2. St. Mary Magdalen..	1,865	13,934	7·5	2,301	17,258	0	0	83	0	4	0	0	87	48·0	
Wandsworth.....	3. Leather Market	2,279	15,295	6·7	2,090	14,003	163	1,092	81	0	0	0	0	81	57·8	Southwark and Vauxhall Co.
	1. Clapham.....	2,657	16,290	6·1	1,106	6,747	22	134	19	0	0	5	0	24	28·1	
	2. Battersea.....	1,760	10,560	6·0	1,046	6,276	46	276	42	0	8	4	0	54	66·9	
Camberwell.....	2. Camberwell.....	2,851	17,742	6·2	1,474	9,139	103	639	96	0	0	0	0	96	104·8	Lambeth Co.
	3. Peckham.....	3,457	19,444	5·6	971	5,438	70	392	59	0	0	0	0	59	108·4	
Rotherhithe.....	Rotherhithe.....	2,792	17,805	6·4	1,909	12,218	0	0	68	0	35	0	0	103	55·6	Southwark and Vauxhall Co.
Totals.....	Totals.....	25,597	169,053	6·5	18,777	128,694	632	4,124	756	0	86	9	5	856	58·7	
Houses in streets where no death occurred	Totals of Table I.....	47,548	317,883	6·6	16,038	107,290	20,554	143,901	507	98	16	20	17	658	47·2	Lambeth Co.
	Not identified .....	..	..	6·4	4,500	28,929	3,643	23,338	0	0	0	0	0	0	..	
	Totals of thirty-two Sub-districts..	Totals of thirty-two Sub-districts..	73,145	486,936	6·6	39,726	267,625	24,854	171,528	1,263	98	102	29	22	1,514	47·2	5·7

TABLE V.

Shewing the results of the Inquiry for the whole Epidemic of 1854.

Registration Districts.	Number of inhabited houses in 1851.	Population in 1851.	Estimated constant population per house.	“Number of houses, and estimated number of persons, supplied in 1854 with water as under.”				Deaths from cholera in the epidemic of 1854.				Mortality per 10,000 supplied with water as under.		
				By the Southwark and Vauxhall Co.		By the Lambeth Company.		Southwark and Vauxhall Co.	Lambeth Co.	Pump-wells and other sources.	Supply not ascertained.	Deaths from cholera in the epidemic of 1854.	Southwark and Vauxhall Co.	Lambeth Co.
				No. of houses.	Estimated population	No. of houses.	Estimated population							
St. Saviour, Southwark.....	4,600	35,731	7·8	2,631	19,617	1,689	14,201	406	72	10	3	491	207	50
St. Olave, Southwark.....	2,360	19,375	8·2	2,193	18,638	0	0	277	0	8	28	313	148	..
Bernondsey.....	7,007	48,128	6·9	8,402	57,884	268	1,785	821	0	25	0	846	142	..
St. George, Southwark.....	6,992	51,824	7·4	3,419	25,039	3,183	23,712	388	99	0	56	543	155	41
Newington.....	10,458	64,816	6·2	5,224	31,940	5,473	33,531	458	58	2	176	694	143	17
Lambeth.....	20,447	139,325	6·8	8,077	54,982	11,763	83,786	525	138	24	240	927	96	16
Wandsworth.....	8,276	50,764	6·1	3,028	18,390	618	3,870	268	7	106	40	421	145	18
Camberwell.....	9,412	54,607	5·8	4,005	23,472	1,835	10,478	352	33	115	49	549	150	31
Rotherhithe.....	2,792	17,805	6·4	2,336	14,951	0	0	207	0	46	30	283	138	..
Greenwich & sub-dis. Sydenham.	..	..	..	..	..	..	..	4	4	2	1	11	..	..
Houses not identified.....	..	..	6·6	411	2,712	25	165	..	..	..	..	..	..	..
Totals.....	72,344	482,435	6·7	39,726	267,625	24,854	171,528	3,706	411	338	623	5,078	138	23
Non-ascertained cases distributed in proportion of others}	561	62
Population (Registrar-General)	266,516	..	173,748	4,267	473	338	..	5,078	160	27

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